EPIDEMIOLOGY AND CONTROL OF

MALARIA

IN INDIA

1996

R. S. SHARMA
G. K. SHARMA
G. P. S. DHILLON

सत्यमेव जयते

Government of India
Ministry of Health & Family Welfare
NATIONAL MALARIA ERADICATION PROGRAMME
(Directorate General of Health Services)
22-Shamnath Marg, Delhi-110 054

EPIDEMIOLOGY AND CONTROL OF MALARIA IN INDIA 1996

R. S. SHARMA
G. K. SHARMA
G. P. S. DHILLON

सत्यमेव जयते

Government of India
Ministry of Health & Family Welfare
NATIONAL MALARIA ERADICATION PROGRAMME
(Directorate General of Health Services)
22-Shamnath Marg, Delhi-110 054

FIRST EDITION 1996

Printed by :- **SHAKUN ENTERPRISES**, 4002, Raghu Ganj, Chawri Bazar, Delhi-6 ☎ 2918136

धर्मार्थ काम मोक्षणामारोग्यं साधनं यतः
तस्मादारोग्यं दानेन यद्दत्तं स्याच्चतुष्टयम्

— *स्कन्द पुराण*

"Health is the instrument for achieving the spiritual, material, emotional and salvational objectives of human life. Hence persons imparting health to others, achieve all the four objectives automatically."

— *Skand Puran*

DEDICATED TO WORKERS ENGAGED IN MALARIA CONTROL

मलेरिया नियंत्रण में लगे सभी कर्मचारियों को समर्पित

PREFACE

Malaria continues to be a major public health problem in India in spite of the programme being in operation without interruption for nearly four decades. Though the disease was reduced to almost eradicable level in 1965, its resurgence over subsequent years with rapid escalation of malaria cases necessitated the introduction of Modified Plan of Operation (MPO) in 1977. The erstwhile vertical programme metamorphosed into horizontal operation for case detection and treatment through Primary Health Care Services. The introduction of MPO contained the escalating trend and during the last one decade the incidence has stabilised around two million cases per year, in spite of 25 per cent increase in population during the decade. The alarming aspect of malaria is that proportion of *Plasmodium falciparum* cases has increased from 15% to 40% of total cases in the country over the last four decades.

The spurt in *Plasmodium falciparum* cases specially in areas experiencing epidemics during 1994 in some States prompted the Government of India to appoint an Expert Committee on Malaria. Following the recommendations of the Expert Committee, the Directorate of National Malaria Eradication Programme brought out an 'Operational Manual for Malaria Action Programme' in 1995, which can be used as a guideline for implementation of the recommendations given by the Expert Committee.

The present publication has been brought out by the Directorate of NMEP to meet the demands of different levels of workers engaged in malaria control and research scholars involved in malaria work. The first chapter deals with economic aspects (cost-effective and cost-benefit analysis) of malaria control programme in India to justify that the malaria control efforts should not be curtailed on account of resource crunch. Though the country has been spending a large amount of resources on malaria control, the cost-benefit analysis reveals that every rupee invested in malaria control provides a benefit of Rs. 22.10.

Measurement of malaria not only encompasses the conventional classification of endemicity based on spleen rates among children but also current malariometric indices followed in the national programme. The relative significance of Slide Positivity Rate and Annual Parasite Incidence in relation to Annual Blood Smear Examination Rate have been succinctly discussed to give an insight on how to use the correction formula where the blood smear collection is erratic. This will help the programme managers to correctly interpret the data for incorporating appropriate remedial measures.

Chemotherapy has been given very elaborate treatment to help clinicians in the endemic areas to acquaint themselves with the correct dosage and contra-indications of different drugs. Principles for evolving national antimalaria drug policy are highlighted for the benefit of programme managers and policy decision makers. The Government of India appointed a committee of experts on National Antimalaria Drug Policy in 1995 and the recommendations replacing the earlier drug policy have been reproduced in a separate section which shall be followed by the drug dispensers at the periphery of the national programme.

The timely management of complicated malaria is a panacea for elimination of deaths due to malaria. This topic has also been dealt with in detail so that the peripheral workers will be able to detect complicated and severe malaria cases and immediately refer them to the nearest referral centre. The clinicians will find this chapter very handy for management of severe and complicated malaria.

The chapter on malaria paradigms gives an insight into the intricacy of transmission dynamics which differ in space and time and determine the local and focal phenomenon so often seen in distribution of malaria endemicity. This will help the peripheral programme managers to plan and implement the control strategy based on sound knowledge of transmission dynamics. The stratification of malarious areas has been covered including recommendations of the Expert Committee on Malaria -1995.

The war against malaria cannot be won by merely deploying highly potential weaponry. The sound strategy with thorough planning in using such arsenal will pay quick dividends in exterminating the scourge. Thus the chapter on planning of malaria control operations gives sufficient insight into this aspect. We advise all programme managers at State, District and peripheral levels to understand and assimilate the various facets of planning of successful control operations. Due coverage has been given on the use of environmental friendly methods of vector control. The pros and cons of decentralisation of malaria control operations have been discussed which are relevant in the present day context.

Integrated disease vector control approach will be the future strategy in the national programme covering not only malaria but also other vector borne diseases like filaria, kala-azar, Japanese encephalitis, dengue, etc. Environmentally persistent insecticides like DDT and BHC will be soon phased out from the programme and environmental friendly methods through community participation, personal protection

and use of impregnated bednets will be implemented in areas from where the indoor residual spray will be withdrawn. The relevant areas for applied and operational research have also been identified. The major aspects pertaining to future strategy including organisational aspects have been detailed in Chapter-7.

A separate chapter on engineering methods for mosquito control with illustrations for the benefit of public health workers has been included in the book. Manpower development plays a pivotal role for successful implementation of any national programme. There is an urgent need for imparting orientation training on the new strategy to different tiers of health personnel and the capacity building for the control of malaria and other vector borne diseases has been highlighted in the last but one chapter.

The Directorate of NMEP in one of its earlier publications i.e. 'Malaria and its Control in India'- 1985 gave districtwise and yearwise relevant epidemiological information from inception of malaria eradication programme in the country. An attempt has been made to update this knowledge by providing this information up to 1995 in the last chapter which will be of immense value to all malaria workers in different areas to know the trend of the disease in other parts of the country.

Though every care has been taken to present factual information, some inadvertent errors would have come in this publication and we own the responsibility for the same. We will appreciate receiving any comments and suggestions on this book. Views expressed in this book, covering the malaria epidemiology and its control do not necessarily reflect the control policy being followed by the Directorate of NMEP, Government of India, Ministry of Health & Family Welfare.

(R.S. Sharma)
Director

(G.K. Sharma)
former Director

(G.P.S. Dhillon)
Joint Director

Delhi
July, 1996

ACKNOWLEDGMENTS

We express grateful thanks to all our colleagues of the Directorate of National Malaria Eradication Programme without whose whole hearted support and total dedication, it would not have been possible to complete this book. We are grateful to the staff of the Assessment Section of NMEP for updating the malaria incidence data of States / districts and other parameters and to Mr. Ajit Pal Singh for computer data output. We are also thankful to Shri S.P. Nanda for drawing charts, graphs and maps. For his excellent secretarial assistance, we are grateful to Shri S.K. Katyal.

We are grateful to all the Officers in the Ministry of Health & Family Welfare and Director General of Health Services and his colleagues for encouraging to undertake this gigantic task.

We thank the State Governments and Union Territories for supplying the epidemiological data from 1985 to 1995 without which this book could have lost its continuity with the previous publication of the Directorate of NMEP.

Our special thanks are due to Dr. P.C. Gupta, Ex-State Malariologist, Himachal Pradesh and Shri C. Krishna Rao, Ex-Deputy Director (Entomology), NMEP, for diligently collecting and compiling information on various aspects of transmission dynamics of malaria. They deserve special mention for their arduous work of going through the manuscript and giving it the present shape.

Our grateful thanks are due to World Health Organization and SEARO specially Dr. N. K. Shah, WR to India, Dr. V.S. Orlov, Senior Regional Adviser (MAL&VBC), Dr. P.R. Arbani, Regional Adviser for Malaria and Dr. P. Chusak, Regional Entomologist for providing information on Revised Global Strategy on Malaria and valuable interactions on various aspects.

We are grateful to Dr. S Pattanayak, Ex-Director of NMEP, Dr. K.K. Datta, Director NICD and Dr. V.P. Sharma, Director MRC for their encouragement from time to time in controlling malaria in India during critical juncture of the resurgence of malaria during 1994-95 and their ideas have been reflected in this book.

We also express our gratitude to the World Bank authorities on Malaria and also to the experts of British Overseas Development Administration and its related agencies in U.K. for their critical comments on the various issues related to the development of malaria control Programme in India.

We are thankful to M/s Shakun Enterprises, Delhi for printing the book at a short notice.

SECTIONWISE CONTENTS

TOPICWISE CONTENTS

(Continued on Page 752)

1

ECONOMICS OF MALARIA CONTROL PROGRAMME

INTRODUCTION

Economic considerations play a key role in all aspects of human life including health. The developmental activities of the country besides other factors influence the nature and type of epidemiological profile of the disease. Essentially economic considerations in health or health related problems help in two main spheres pertaining to planning of the disease control programme. These are:-

Firstly - in generating the data on health related problems affecting the economy of the country as well as individual. These data assist the planners in determining the priority for control of a particular disease out of many prevalent in the area, and

Secondly - in formulating plans for efficient execution of control operations by strengthening the infrastructure suitably within the proposed outlay.

The above would depend on the answers to some of the following questions:-

i. What does community consider as '**good health'** at individual or community level ? Socio-economic and health surveys should be conducted to find out the community perception on the magnitude of adverse impact of prevalent diseases in the area. These surveys will help in pinpointing the relative importance of a particular disease, as perceived by the community which would enable to seek their active participation and cooperation in the implementation of control measures.

ii. Which disease prevalent in the area has a more severe adverse effect on the economic progress of the community by inducing morbidity, debility, disability and premature death and if so, to what extent and in which segment of the population ?

iii. Whether it is for the sake of individual or community 'health' alone or for 'economic' gains likely to accrue to the nation or for both reasons that a disease control programme should be initiated ?

iv. What significant part the disease control programme will play in consolidating country's economic growth by improving the health status of the community ?

v. What is economic efficiency of existing health services infrastructure and what improvements and extra inputs are required to implement control measures ? Further, what are the organisational capabilities adequate enough to surmount problems encountered in the course of achieving the targets/objectives ? Will such an organisation fulfill the dictum of maximum efficiency with minimum expenditure ?

vi. Is it possible to establish a technically well trained and operationally sound organisation or the existing one can be strengthened for implementing appropriate control measures within the resources available ?

vii. What criteria should be laid down for decision making while prioritising control of a specific disease from among many of the diseases prevalent in the community ?

viii. Should a decision to implement a disease control programme be based on philosophical and cultural related 'values' encompassing various aspects of community life such as moral, ethnic, cultural, social, bio-environmental situation prevalent in and around the community or purely on economic related aspects ?

Whenever 'crude' economic analysis is applied to health and health related problems, paradoxically it sometimes produces contradictory conclusions, making it very difficult for the administrators to decide on the usefulness of methods dealing with health problems, with respect to 'cost effective', 'cost benefit' and 'ethical aspect' of options. Thus economic parameters should be chosen very carefully while assessing the 'cost benefit ratio' of control operations and care should be exercised right from the beginning to the end of the exercise.

While determining the 'cost benefit ratio' of control programme, some of the economic questions raised by Bradley on utilisation of services of the health worker when applied to the Indian scenario should be answered. For example:

a. How does one compute the cost of community health worker and assess the benefit accrued through him/her by the rural community ?

b. Is it true or not that the community based programmes are more cost effective than the hospital services ?

c. How do the utilisation and allocation of funds for community health services compare, as against the 'benefits' accrued to the community from control services in the rural areas ? Can this be precisely calculated ?

If answers to all the questions mentioned above are not precise and conclusive, then it is not possible to allocate precise value to the disease in economic terms.

The cultural and ethnic problems related to disease prevalence or subsequently arising as a result of control measures instituted in the community against such a disease are to be considered in depth before planning control measures. This is a prospective forecasting of the possible beneficial or adverse impact of suggested/proposed control measures and it should be a part of planning exercise.

CORE GROUP FOR ASSESSMENT OF ECONOMICS OF DISEASE CONTROL PROGRAMME

While planning the programme for a disease control, one must look into the conceptual profile of the main specialised groups related with this subject.

Medical profession, being the most informed stratum of the society on health aspects, can give a balanced opinion on health related subjects as regards the severity of disease, its prevalence and sequelae. But by virtue of their professional training, ethically medical personnel **assign 'highest value' to human life. They try to save human life at 'any cost'**. They usually prescribe the 'latest medicines' and use the 'best techniques' available to save an individual or to prolong his life irrespective of the cost involved to the individual or the society. In other words, their **aim is to improve the 'quality of life' of the patient** irrespective of cost involved. Sometimes they forget to visualise whether the cost is affordable or not and whether the recurrent expenditure can be met or not in future and if so from which source and where its adverse economic impact will be ultimately reflected. They do not think in terms of an alternative, which may be 'equally effective but cheaper'.

Similarly, the medical professionals who specialise in community health also tend to regard that the prevention of a disease in the realm of their own speciality is a top priority subject and its immediate control is necessary for the community benefit. They also formulate control programme adopting the best technology available which is likely to yield results in the shortest

possible time. Here again usually they advocate measures irrespective of the cost involved.

Although it may be conceded that 'cheapest' way is not always the most 'economical' method of dealing with the health problem of an individual or community, at the same time neither the costly nor complicated technology is the most effective measure in dealing with the problem. When an appropriate technology is addressed to a health problem, it should be scientifically sound, acceptable to the implementors and to those for whom it is provided. Such a technology should also be sustainable both economically and technically because all control programmes continue over a long period of time. Therefore, it is essential to decide 'what', 'where' and 'how' to provide a remedial measure for protecting people within their surroundings on long term basis at a'cost effective' level and here lies the sense of balance in health administrator's decision making task.

As is the general practice, the medical professionals do their best and only in rare cases seek advice from other disciplines. Such an advice may be limited to the investigations which will help them in making up their own opinions or determining options. They seldom involve other disciplines i.e. people outside the medical profession in decision making specially regarding the choice of technical tools, organisational pattern and administrative structure of the organisation. Therefore, on many an occasion even a very well planned disease control operation fails to achieve the desired goal, fixed by programme planning/ implementing authorities.

Economists and Social Scientists are the other professionals who may help in developing economically viable and sound proposals on health care. By and large, for a very long time, the economists worked in isolation on subjects of their own choice except for a handful of them who studied the health related problems. For the majority of the economists and social scientists, even till recently the health and health related problems had a mystique connotation. They considered that health matters concerned medical profession alone and followed the dictum that 'doctor knows the best'. For similar reasons, in the past the sociologists while studying many aspects of human life related to the ethnic and cultural behaviour including the subjects like 'what community wants or feels about the disease', have seldom conveyed this information to public health experts. The public health personnel before formulating disease control plans should know the studies popularly known as KAP i.e. Knowledge, Attitudes and Practices in respect of the community group(s) specially regarding the cause of disease, its prevalence, mode of transmission and treatment as understood by different cultural groups.

The element of KAP has been introduced with a view that the health related services are better utilised by the community as well as to obtain active participation of the community in control efforts made by Government organisation.

Since large scale control programmes against various diseases involving huge expenditure have been implemented or contemplated only recently, the economists have started taking interest in this subject. In the beginning, the interest was limited to the development of treatment facilities for the sick and methods to 'cut down' the expenditure by better drug compliance and management.

ASPECTS RELATED TO PRIORITY ALLOCATION FOR THE CONTROL OF DIFFERENT COMMUNICABLE DISEASES

i. Distribution Pattern of Diseases in Tropics/ Sub-Tropics

There are a plethora of communicable diseases prevalent in tropics and sub-tropics which are distributed in areas 40^0 North and 40^0 South of Equator. At the fringe areas of disease prevalence, the disease endemicity and its transmission are very delicately balanced and disease control can be easily managed here. As regards communicable diseases transmitted by vectors, there are some which are widely distributed but almost all of them have a focal characteristic - for example malaria, schistosomiasis, guineaworm disease, kala-azar and filariasis. Out of these communicable diseases, malaria is most widely prevalent in tropical countries. About 40% of the global population was exposed to the risk of the disease in 1994. The distribution of malaria endemicity/prevalence is also focal in nature and its intensity varies from area to area.

ii. Vectorial Influences

The distribution of vector borne diseases depends on the presence of vector and the extent of its distribution as determined by vector bionomics, the vectorial capacity and many other factors which influence frequency of 'man-vector' contact. In equatorial Africa, South of Sahara, malaria transmission is very intense. In India, there are tracts of intense malaria with hyperendemicity, while in large areas (nearly 53 per cent of the country), malaria endemicity is low and within these areas there are pockets where malaria was not prevalent or its local transmission was at a very low level even in pre-control era, while in some pockets periodic fulminating epidemics were recorded in the past (Fig-1.1) The malaria situation in India based on API stratification during 1990 and 1994 is depicted in Fig-1.2 and Fig.-1.3 respectively.

Based on filaria survey, an estimated population of 412 million out of 920 million population of India residing in rural and urban areas is exposed to the risk of filariasis with local transmission (Fig-1.4). Kala-azar is limited to Gangetic plain involving a population of about 75 million (Fig-1.5) while guineaworm problem is limited to arid and semi-arid areas with water scarcity in North Western India and certain other States affecting a population of about 0.8 million only (Fig-1.6). The above statistics indicate the magnitude of malaria problem and its place within the profile of communicable diseases in India.

iii. Consideration of Morbidity and Mortality Patterns

The morbidity and mortality patterns of these diseases vary widely. Malaria produces acute episodes, a severe clinical picture, but if treated in time, the morbidity can be reduced and limited to a very short period of time. However, by virtue of its extensive distribution, high reproduction rate and very short incubation interval, it affects very large population resulting in morbidity and disability in a large section of the community, sizable premature mortality in vulnerable groups and even in quite a big section of working population. This unique distribution pattern adversely affects the national economy. On the other hand, filaria, kala-azar and guineaworm disease due to low reproduction rates, longer incubation intervals, etc. produce limited morbidity but extensive disability in those afflicted, thereby reducing the working capacity during their economically active period of life.

iv. Importance of Selecting Right Set of Economic Parameters for Estimating Health Problem

Consideration of right type of parameters for assessing the economic aspects is another dimension of the problem. One of the examples relates to a study on economic aspects of schistosomiasis in St. Lucia Island, where a group of economists assessing the problem and the adverse impact of infection among local workers observed that there was no difference in the productivity and efficiency of infected group as compared to non-infected group. They also found that there was no significant impact on morbidity, school attendance, fertility and mortality. Hence they concluded that control of schistosomiasis did not carry economic justification on that Island.

However, another group mainly of health experts, making a similar study in a Middle East country opined differently. They observed that as the disease produced high disability and morbidity in the population, it deserved top priority for undertaking control measures. Thus the subject of 'priority' of control measures against schistosomiasis was mired in controversy.

For the above reasons economists and health experts should coordinate the investigation right from the very beginning, so as to avoid later controversies. A conscientious decision is to be taken regarding 'priority' grading of prevalent diseases in the area and instituting disease control measures.

v. 'Cost of Sickness' - Financial Losses due to Prevalence of a Disease

In computing the **'cost of sickness'** or **'financial losses'** due to a disease to the individual or its presence in the community, a large number of items are involved and it is difficult to identify all such parameters. Further, it is much more

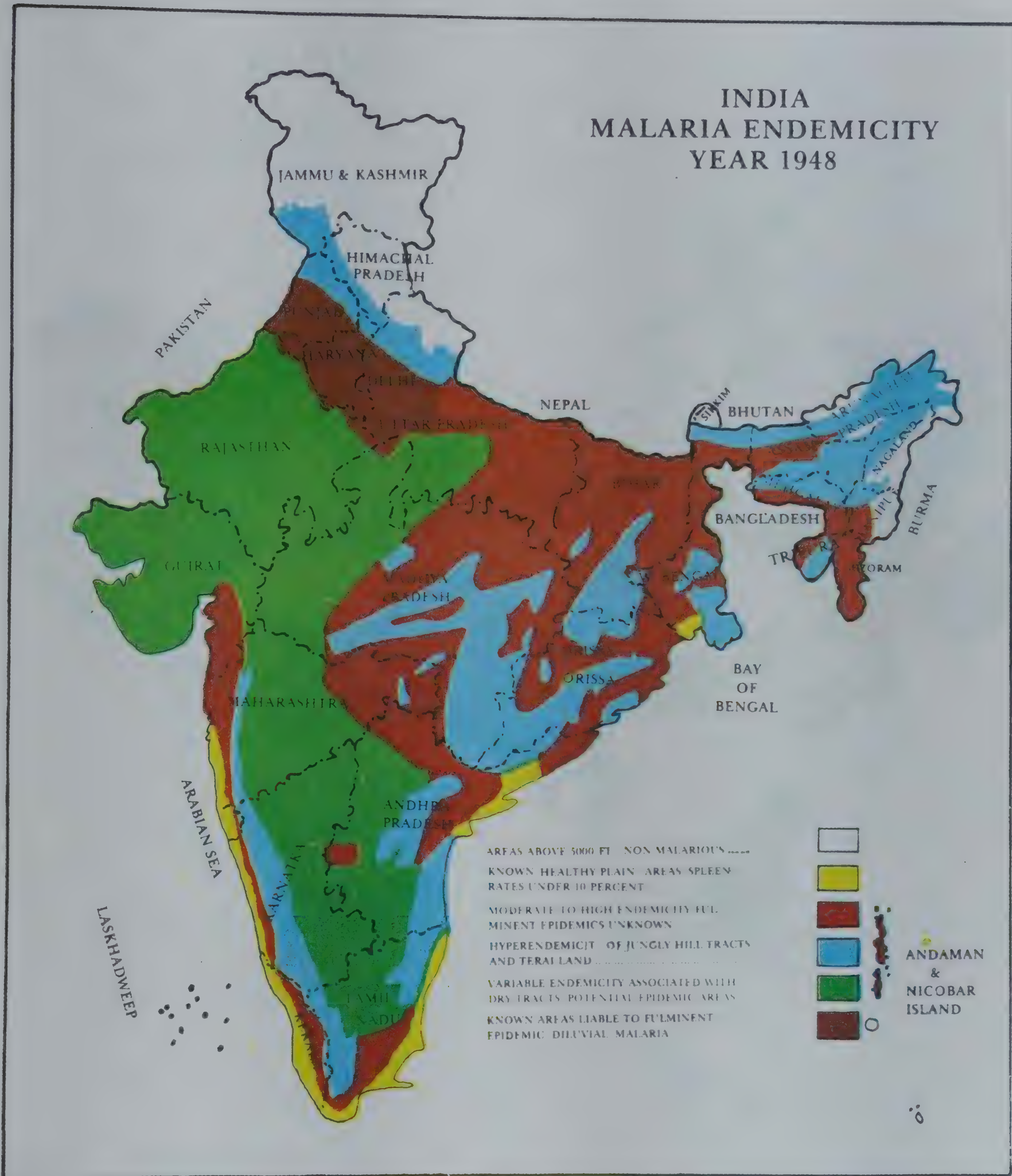

INDIA
MALARIA ENDEMICITY
YEAR 1948
JAMMU & KASHMIR
HIMACHAL PRADESH
PAKISTAN
NEPAL
SIKKIM
BHUTAN
BANGLADESH
BURMA
RAJASTHAN
MADHYA PRADESH
ORISSA
BAY OF BENGAL
MAHARASHTRA
ARABIAN SEA
ANDHRA PRADESH
LASKHADWEEP
AREAS ABOVE 5000 FT NON MALARIOUS
KNOWN HEALTHY PLAIN AREAS SPLEEN RATES UNDER 10 PERCENT
MODERATE TO HIGH ENDEMICITY FULMINENT EPIDEMICS UNKNOWN
HYPERENDEMICIT OF JUNGLY HILL TRACTS AND TERAI LAND
VARIABLE ENDEMICITY ASSOCIATED WITH DRY TRACTS POTENTIAL EPIDEMIC AREAS
KNOWN AREAS LIABLE TO FULMINENT EPIDEMIC DILUVIAL MALARIA
ANDAMAN
&
NICOBAR
ISLAND

Fig- 1.1

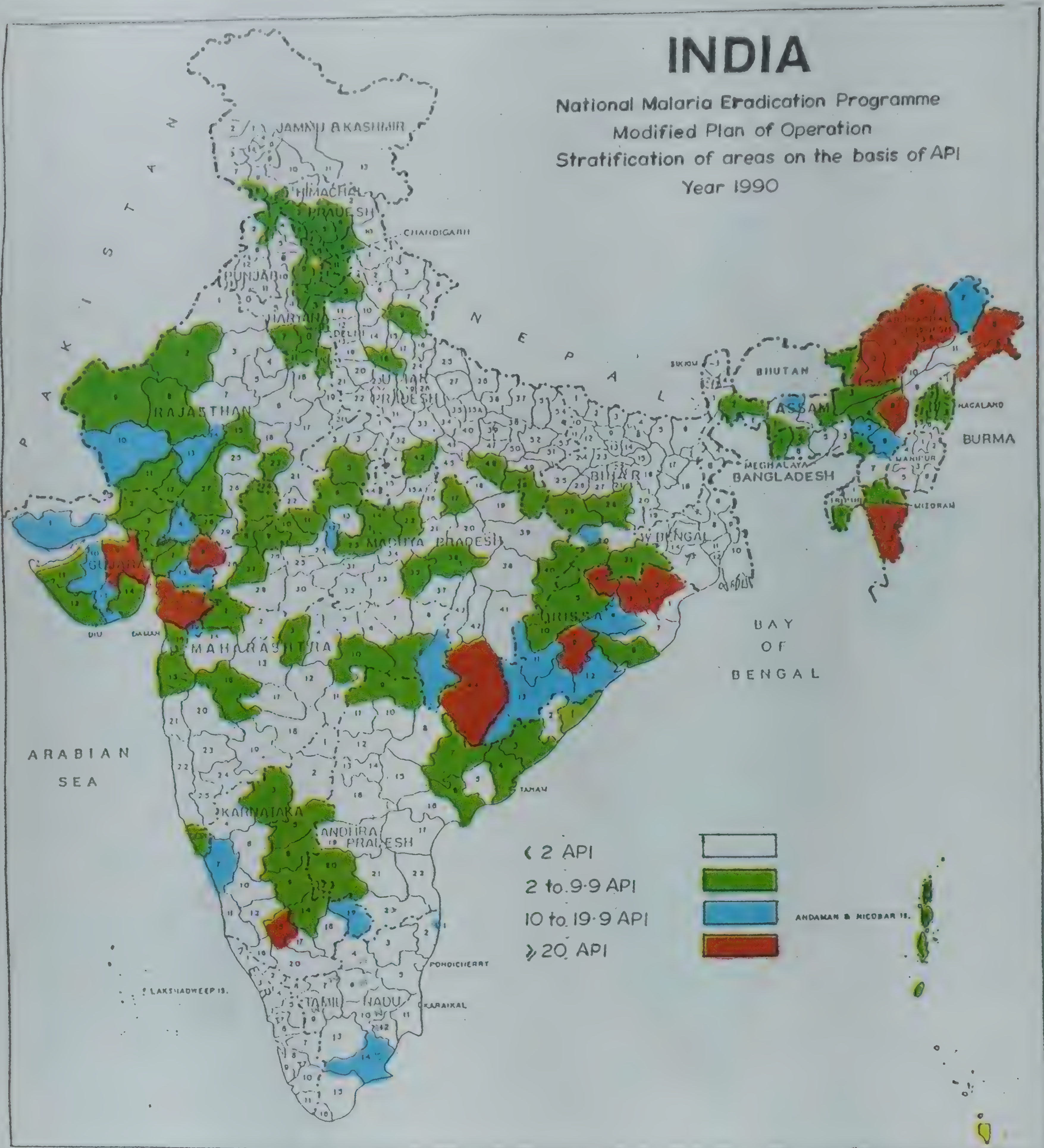

INDIA
National Malaria Eradication Programme
Modified Plan of Operation
Stratification of areas on the basis of API
Year 1990
< 2 API
2 to 9·9 API
10 to 19·9 API
≥ 20 API
ARABIAN SEA
BAY OF BENGAL
PAKISTAN
NEPAL
BHUTAN
BANGLADESH
BURMA
ANDAMAN & NICOBAR IS.
LAKSHADWEEP IS.

Fig- 1.2

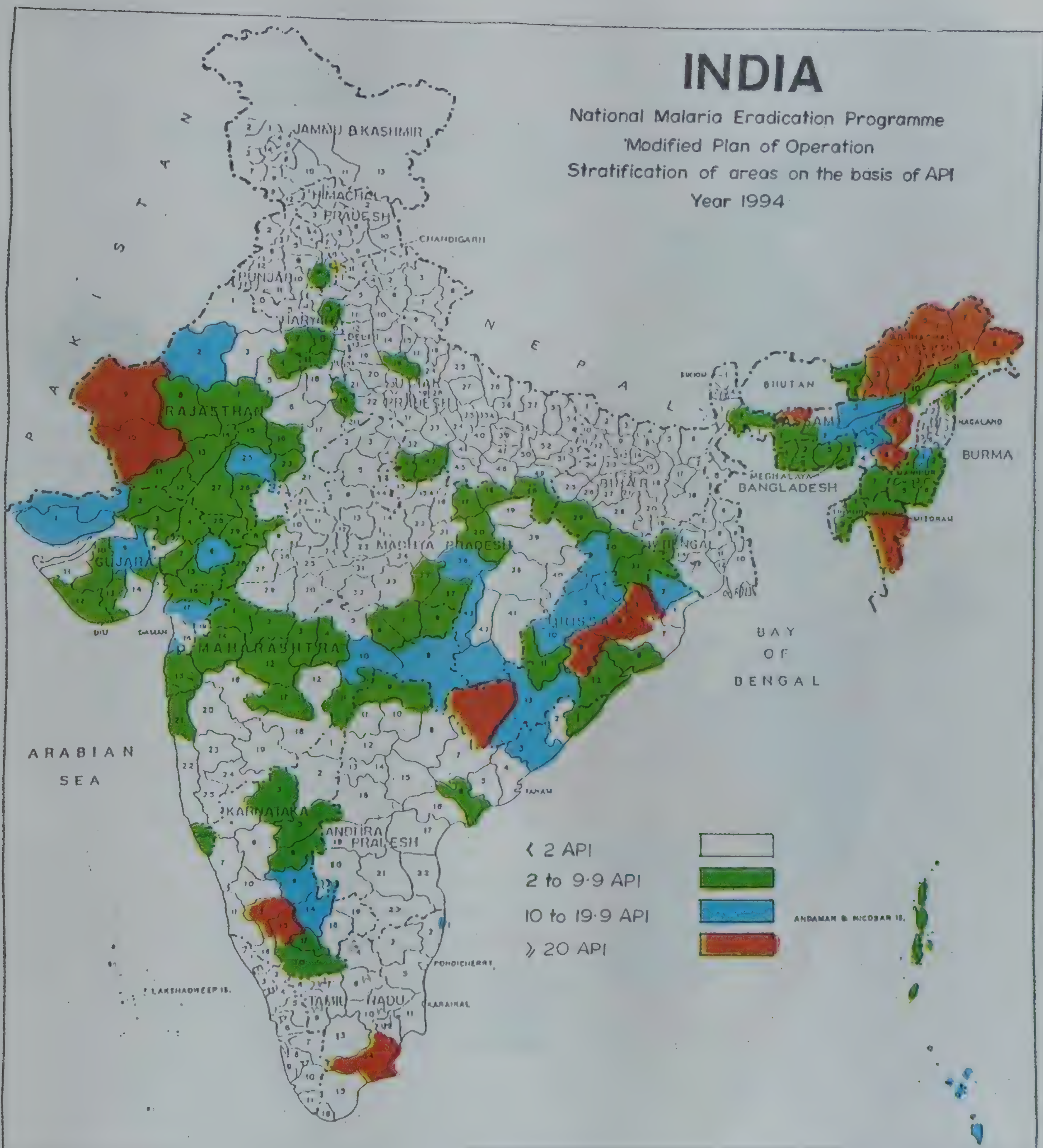

INDIA
National Malaria Eradication Programme
Modified Plan of Operation
Stratification of areas on the basis of API
Year 1994
JAMMU & KASHMIR
HIMACHAL PRADESH
CHANDIGARH
PUNJAB
HARYANA
DELHI
UTTAR PRADESH
RAJASTHAN
GUJARAT
MADHYA PRADESH
BIHAR
BENGAL
ORISSA
MAHARASHTRA
KARNATAKA
ANDHRA PRADESH
TAMIL NADU
PONDICHERRY
KARAIKAL
YANAM
DIU
DAMAN
LAKSHADWEEP IS.
ANDAMAN & NICOBAR IS.
PAKISTAN
NEPAL
SIKKIM
BHUTAN
ASSAM
NAGALAND
MANIPUR
MIZORAM
MEGHALAYA
BANGLADESH
BURMA
BAY OF BENGAL
ARABIAN SEA
< 2 API
2 to 9·9 API
10 to 19·9 API
≥ 20 API

Fig- 1.3

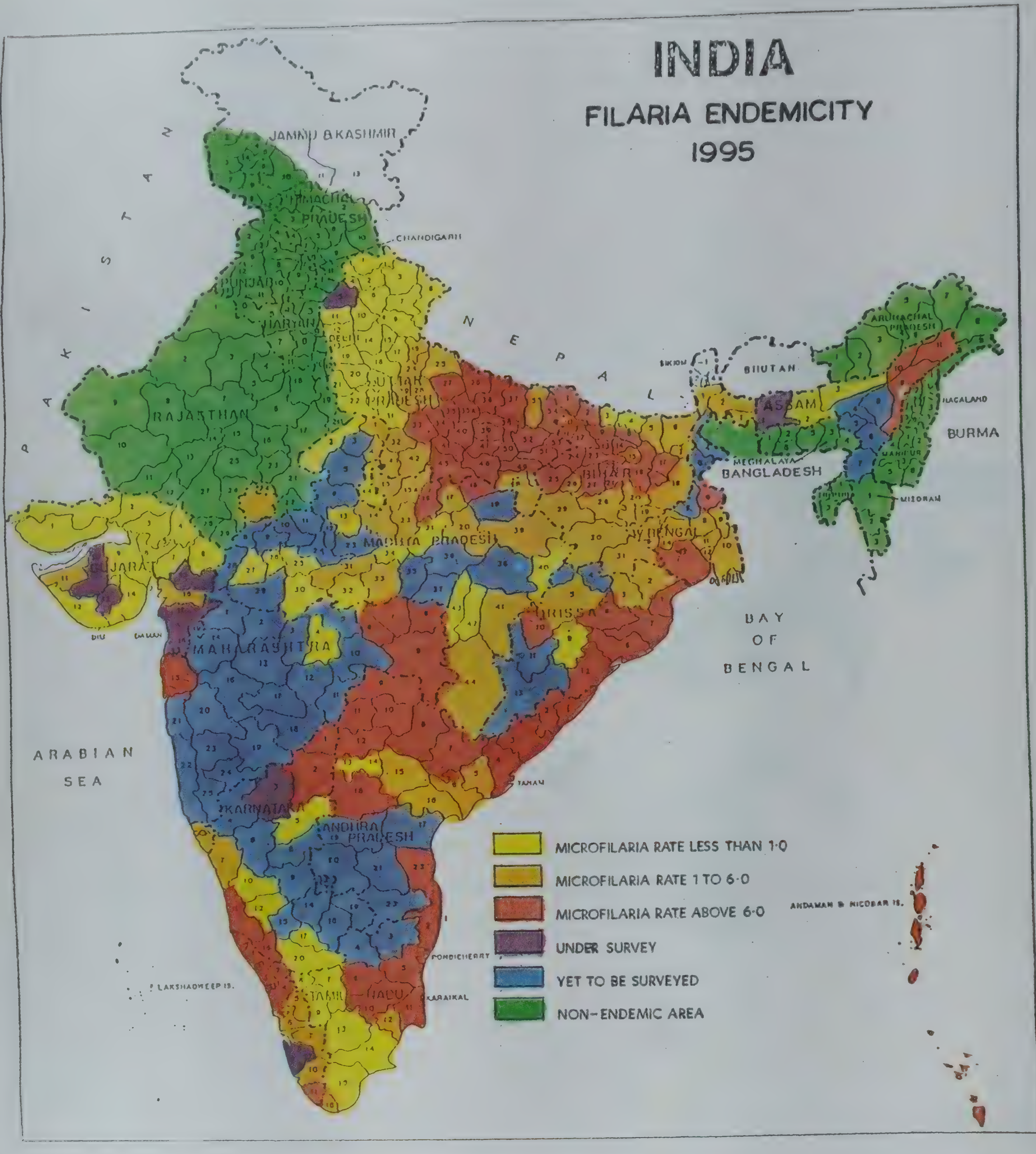

INDIA
FILARIA ENDEMICITY
1995
JAMMU & KASHMIR
HIMACHAL PRADESH
CHANDIGARH
PUNJAB
HARYANA
DELHI
RAJASTHAN
UTTAR PRADESH
NEPAL
SIKKIM
BHUTAN
ARUNACHAL PRADESH
ASSAM
NAGALAND
BURMA
MEGHALAYA
BANGLADESH
MANIPUR
MIZORAM
BIHAR
W. BENGAL
GUJARAT
MADHYA PRADESH
ORISSA
MAHARASHTRA
BAY OF BENGAL
ARABIAN SEA
DIU
DAMAN
KARNATAKA
ANDHRA PRADESH
YANAM
TAMIL NADU
PONDICHERRY
KARAIKAL
LAKSHADWEEP IS.
ANDAMAN & NICOBAR IS.
PAKISTAN
MICROFILARIA RATE LESS THAN 1·0
MICROFILARIA RATE 1 TO 6·0
MICROFILARIA RATE ABOVE 6·0
UNDER SURVEY
YET TO BE SURVEYED
NON-ENDEMIC AREA

Fig- 1.4

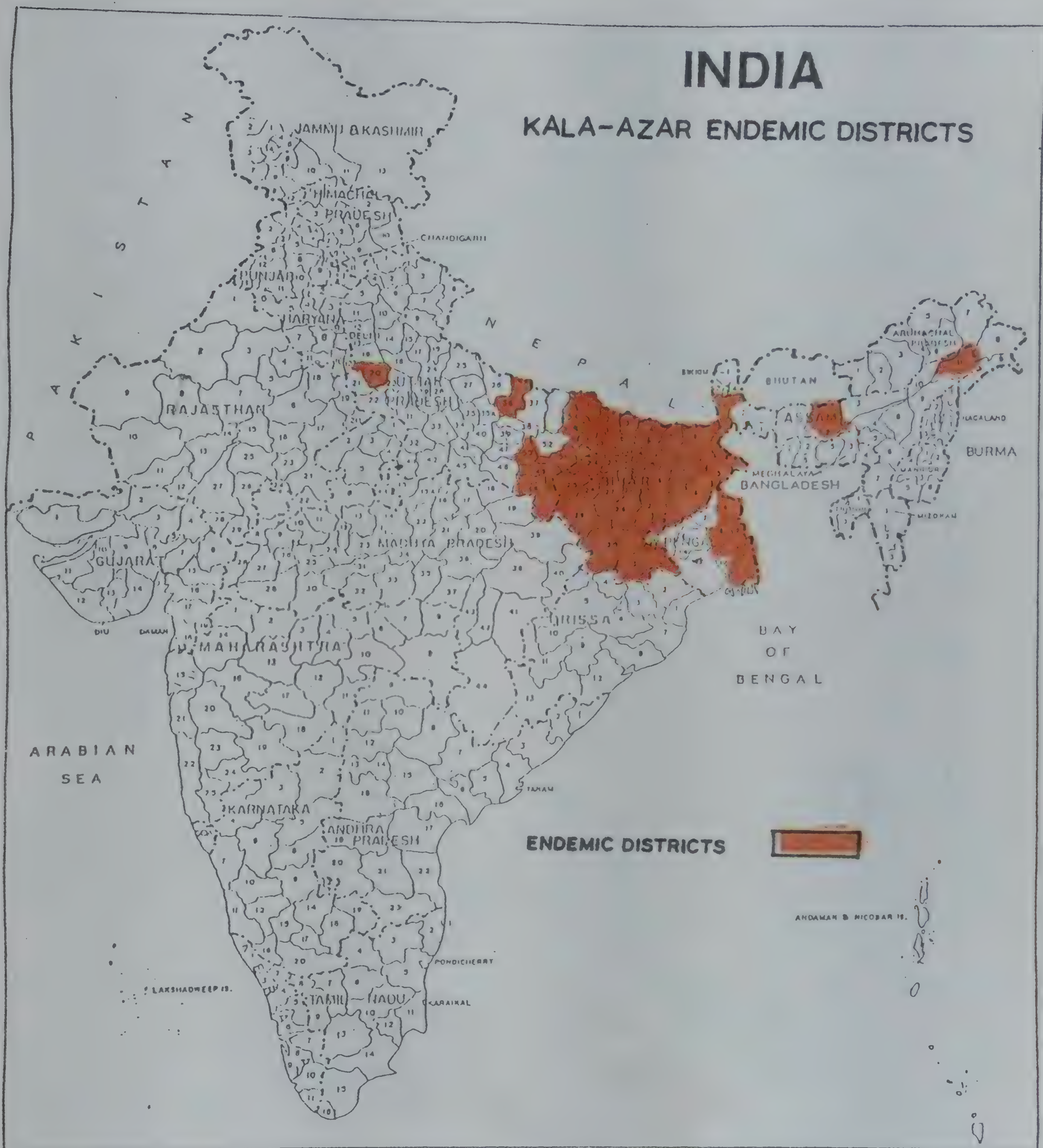

INDIA
KALA-AZAR ENDEMIC DISTRICTS
ENDEMIC DISTRICTS
PAKISTAN
NEPAL
BHUTAN
BANGLADESH
BURMA
BAY OF BENGAL
ARABIAN SEA
JAMMU & KASHMIR
HIMACHAL PRADESH
PUNJAB
HARYANA
DELHI
RAJASTHAN
UTTAR PRADESH
BIHAR
GUJARAT
MADHYA PRADESH
MAHARASHTRA
ORISSA
ASSAM
MEGHALAYA
KARNATAKA
ANDHRA PRADESH
TAMIL NADU
ARUNACHAL PRADESH
NAGALAND
MIZORAM
CHANDIGARH
SIKKIM
DIU
DAMAN
PONDICHERRY
KARAIKAL
LAKSHADWEEP IS.
ANDAMAN & NICOBAR IS.

Fig- 1.5

Guineaworm Endemic Districts In India

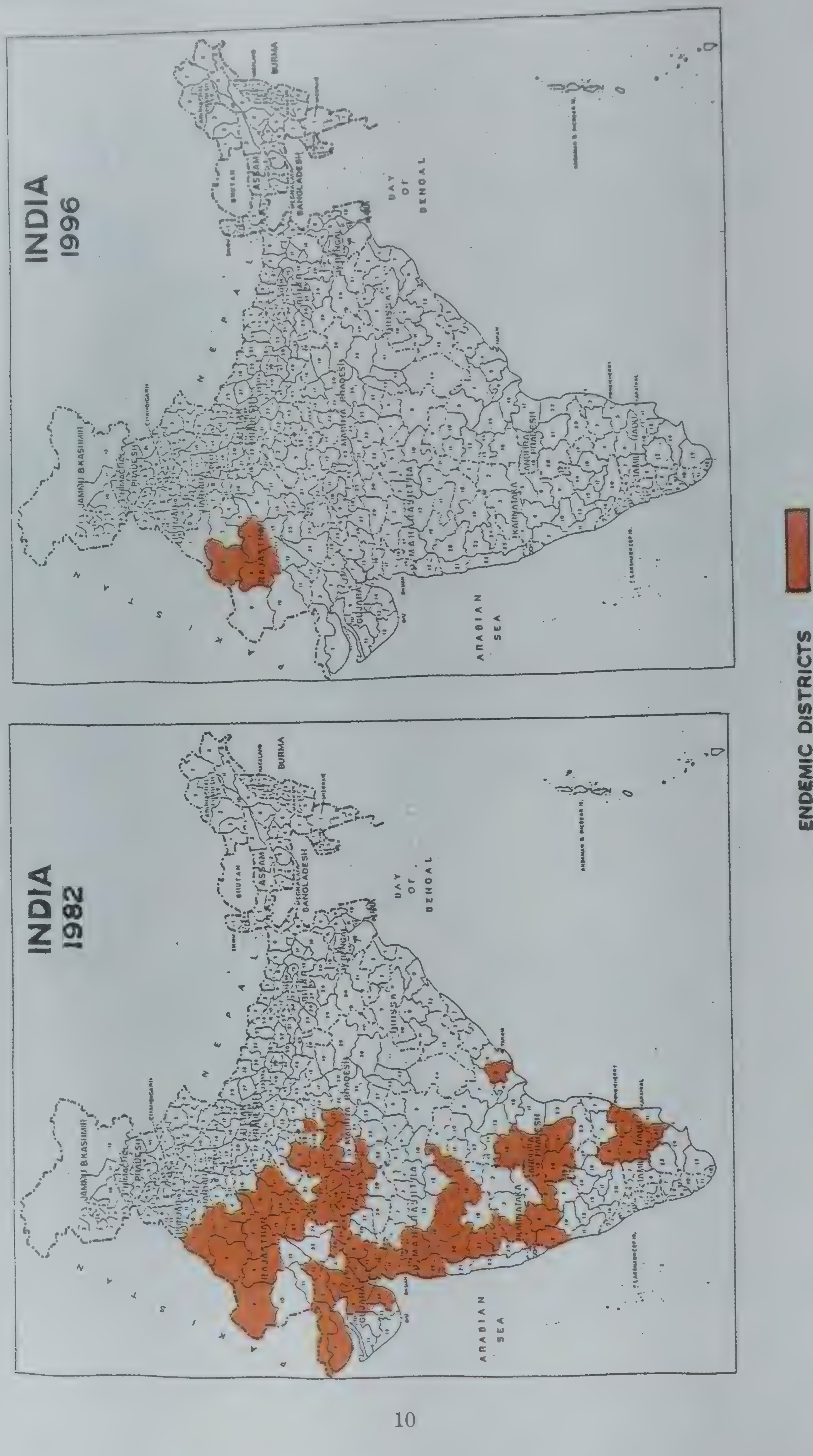


Fig- 1.6

difficult to choose from all the identified parameters, a set of parameters which are of prime importance in relation to economic and health aspects of the disease. Collection of data on these parameters requires extensive investigations coupled with a thorough insight of socio-economic forces. It also requires a rational interpretation of data collected during the survey.

The method of investigation and the set of parameters to be collected vary with the type of disease as well as the community affected. For example, hookworm infestation is widely prevalent in most of the tropical countries but the incidence is highest in communities engaged in agricultural activity causing high morbidity. It is difficult to work out with a fair degree of precision, the 'cost of sickness' and the consequent economic loss due to this disease. Further, it is equally tedious to institute control measures. The hookworm infestation and repeated exposures to it are intimately connected with the 'life-style' of the rural community and their agricultural practices. Massive efforts will be required to change the 'life-style' of the community through proper health education, if a campaign against hookworm disease is to be successful.

The 'cost of sickness' is debitable not only to individual but also to the community. The aspects related to 'malaria' are detailed below:

To assess the economic loss to the individual and community on account of malaria, well designed economic surveys should be conducted in rural as well as urban areas. In agriculture and industrial sectors, the economic loss may be computed after taking into account the following:

a. Loss to the individual on account of loss of wages due to malaria morbidity i.e. number of sick days during a year.

b. Loss incurred due to transfer of normal agriculture or industrial job done by the sick person to another individual. This affects the efficiency in job execution as time taken by the substitute is always much more. For example, when a person customarily engaged in sugarcane cutting in the field falls sick and is substituted by another member of the family to attend to this job, there is loss due to decreased efficiency of the substitute. The agriculture activities are time bound and cannot be deferred. A similar situation is obtained in the industry.

c. Losses involved in providing nursing care to sick individual if the person engaged in nursing is a regular wage earning member i.e. a housewife who is also a part-time agriculture worker, is likely to miss her agriculture work when nursing a sick child, thereby losing part of daily wages which she earns by attending to agricultural work.

d. Economic loss to the individual or family due to adverse impact on agriculture or industrial production because of man-days lost at the crucial period of these activities.

e. Individual loss due to expenditure incurred on medicine and treatment.

f. Loss incurred due to expenditure on transportation for obtaining medical help and medicine.

g. Extra expenditure on account of special diet supplement required during convalescence.

h. Loss to the family and community on account of premature death.

i. Cost incurred on funeral ceremonies of the deceased.

It is not enough to compute the loss to an individual or the community due to the disease. It is also necessary to compute the benefit likely to accrue to both the individual and community following disease control measures in the area. This 'cost benefit ratio' may be one of the guiding factors while deciding the priority for control of a disease among many prevalent in the rural masses at a point of time.

ECONOMIC LOSS TO THE INDIVIDUAL, FAMILY AND NATION

i. Expenditure on the Treatment of Sick Person

In case of malaria, depending on the severity of infection, parasite species and delay in commencement of antimalarial, the expenditure on treatment differs from patient to patient. In *P.vivax* or Chloroquine sensitive *P.falciparum*

infection, the cost of treatment per case per episode would work out to about Rs. 5/- (at current costs - 1994).

But if a person is infected with Chloroquine resistant strain of *P.falciparum,* the cost will still be the same as second line of antimalarial drugs i.e. long acting Sulfa plus Pyrimethamine-single dose is cheaper than 3 days treatment with Chloroquine. At the present rates, such cost is computed at Rs. 5/-. In case the patient is hospitalised for treatment of severe and complicated malaria (nearly 0.5 to 2 per cent of *P.falciparum* cases may develop severe and complicated malaria) and Quinine I.V. is used, the cost of treatment for seven days of hospitalisation, antimalarial and supportive treatment works out to over Rs. 700/-. If such a patient is put in a private nursing home, the cost may go up to Rs. 2,285/- or more.

ii. Nursing Cost

The nursing cost even in case of an ambulatory patient depends on the number of fever episodes during sickness before remission occurs. Several studies carried out in India have revealed that the remission of temperature occurs 72 to 120 hours after administration of antimalarial. Therefore on an average, four days of nursing care is absolutely necessary even in those patients who are not hospitalised. As such, while computing the nursing cost in terms of equivalent wage loss which could have been earned by the person nursing the patient over a period of four days may be considered as reasonable. Nursing care at the hospital of seriously sick person is required for at least 7 to 10 days and the cost differs widely from hospital to hospital depending on facilities available.

iii. Cost of Special Diet

It has been estimated that sick/convalescent patients require more calories to compensate for the loss of energy. With each fever episode a loss of 1500 calories is estimated. Therefore, the malaria patients require special diet during the period of sickness and thereafter for a period of at least 7 days. Again the cost computation will depend on the dietary habits of the community in which the patient lives.

iv. Cost of Medical Attendance

By and large under Indian conditions, a fever patient gets free investigations and treatment, provided he attends the Primary Health Centre or through the surveillance machinery of the Government including voluntary agencies. In case primary health care facilities are far away, the patient will have to bear the additional cost of transportation. Therefore, an investigation with adequate sample from different malaria paradigms and social status groups is necessary to ascertain the proportion of people utilising the services of primary health care system *vis-a-vis* those preferring to consult a private practitioner. After such an investigation, the average cost of medical attendance can be calculated. While computing such a cost, the proportionate time spent by primary health care system on investigations and treatment of malaria cases should be worked out and prorata cost calculated. This amount should be accounted for, while working out the average cost of medical attendance of a malaria case.

v. Cost due to Wage Loss

The cost to the individual on account of loss of wages due to malaria, in pre-eradication era was estimated at the rate of loss of seven working days for each attack (Bentley 1911). Another study revealed a loss of 8 working days per attack (Senior White & Newman 1932).

During several studies carried out in different field stations of Malaria Research Centre, it was found that absentee man-days ranged from 7 to 20 in malaria patients. While computing the cost due to nursing care, treatment, etc., a period of 4 days per attack has been taken. This was arrived at by keeping in mind the ready availability of potent antimalarials all over the country and greater awareness as well as time taken to attain amelioration of clinical symptoms after administration of antimalarial. But considering the results of the MRC studies, an average of 8 or 9 days per episode appears to be justified. However, the wage loss to the individual will depend on several factors such as whether the person is a skilled or unskilled, agricultural or industrial

labourer. In case of persons engaged in specialised activities, the wage loss will be much higher.

'It will be fruitful and more scientific to compute all losses incurred by the individual or family as a proportion of their yearly income and not in terms of absolute figures. An average rate of loss incurred by community from different strata of the society can be compiled and applied to calculate what does malaria cost the nation'.

vi. Loss to Family on Account of Death

Financial loss to a worker's family if he or she dies is not very easy to compute. This depends on the wages earned by the worker, age of the worker at the time of death and other sources of family income. All these are to be considered while computing such a loss. **Further, an untimely death adversely affects the rehabilitation of the family, its economic status and future of the dependent children thereby indirectly affecting the quality of life of the prospective labour force of the nation.**

vii. Loss due to Value of Human Life Lost

Premature mortality of any family member irrespective of age at the time of death produces an adverse socio-economic impact on the family life style. Similarly death of an active member of an industrial or agricultural labour force has an adverse effect on gross national product. Calculating the quantum of this loss is a very specialised subject. The reader is advised to consult latest literature on the subject.

viii. Loss to the Community or Nation

These losses are incurred on account of decreased efficiency of individuals who have suffered from malaria and the sequelae incidental to the disease. The magnitude/quantum of such an impact is variable according to distribution of sickness in different strata of the community. In India, when the national economy was mostly dependent on agricultural labour, there was a tremendous loss to national economy on account of malaria, because generally the malaria season all over the country coincides with the sowing and harvesting activities and due to illness of agricultural labour at this juncture a large proportion of the agriculture land remained unutilised. However, in recent times in the wake of mechanisation of agriculture in India, it has become less dependent on manual labour. Thus, presently calculation of loss to the community/ nation on account of malaria in agriculture sector has become more complicated. On the other hand, it is also equally difficult to say that to what extent the malaria control activities have contributed towards increasing the labour production and alleviating the community from deficiency to surplus in agricultural field, because many other factors such as inputs in terms of better seeds, use of fertilisers and pesticides, changes in cropping pattern, provision of canal and other irrigation systems have apparently played greater role in contributing towards surplus agriculture production-while ready availability of skilled labour at reasonable rates as a result of malaria control operations is likely to be treated as a subjective feeling and is difficult to quantify in objective terms. A health administrator can argue that all these extra inputs in the agriculture sector would not have been possible, if malaria was still rampant in the country having an adverse impact on industry on a scale similar to that of pre-eradication days.

ix. Loss to the Industry

In case of unskilled labourers, the industrial loss is not much. The work of such persons can be assigned to auxiliary labourers with reasonable confidence and the output will not suffer significantly. But in case skilled and specialised labourers such as machine operators are absent, the loss to the industry is much higher because some sections of the industry are either closed or run at lower level of production as most of the skilled and unskilled labourers attached to these particular sections will not be utilised at the optimum level. Thus the hidden loss to the industry is much higher in such cases. This eventuality should be kept in mind while calculating loss to industries.

x. Loss to Developmental Projects

Recent studies have shown that in many areas especially during construction phase of projects like industrial township, dams, canals, roads, railways, housing colonies, etc. in spite of control

measures, a relatively high incidence of malaria is recorded in the labour force working in such projects. Simultaneously, the local inhabitants around such projects are also afflicted with malaria on account of malaria focus set up by the tropical aggregation of labour. The positivity rate in the labour force sometimes exceeds 10 per cent. Taking into account that each positive case would be absent from active duty at least for a period of 4 days, it is easy to visualise the adverse impact of such a situation on construction schedule of the project resulting in rise of the cost of the project. It is estimated that nearly 11 per cent or more man-days are lost by the labour force engaged in the project. If in the project, estimated cost ratio between labour and material & equipment is 1:3 or 1:4, the project cost will escalate by 2.5 to 3.5 per cent on account of malaria alone.

OTHER FACTORS RELATED TO DISEASE AND NATIONAL ECONOMY

At a given point of time it is not possible to conclude with fair degree of certainty whether the present disease pattern is the result of overwhelming poverty status of the nation or overwhelming disease prevalence has resulted in retardation of economic progress. A large number of factors related to disease prevalence in a given situation play an important role which are difficult to define or even to identify, as to their appropriate position in the scheme of things.

It is apparent from the points detailed above that the economic survey carried out to ascertain the cost of adverse impact on individual, family or national economy is a specialised subject. Such a survey should not be planned by medical profession alone. Even the research organisation manned by medical and paramedical personnel working in the field of health are not technically equipped to do so because any survey planned by them will not be sound on economic front. As regards the economic aspects, medical personnel do not have expertise in health economy, further a large element of personal bias may creep in the investigation technique and unwillingly the data collected may not be truly representative of the local condition . Therefore socioeconomic impact survey should be entrusted to an independent body which is not likely to be connected with malaria control programme in future. The team should consist of health economists who should in turn co-opt persons like social scientists, or anthropologists, management experts and medical or paramedical personnel to help in conducting socioeconomic surveys in the community. They are likely to give more accurate and reliable advice.

ASSIGNING PRIORITY TO A DISEASE CONTROL PROGRAMME

As mentioned earlier, a large number of factors have to be considered before assigning priority to a particular disease for undertaking extensive control measures. Therefore, at the planning stage, a joint team of Economists, Social Scientists and Health Experts should draw a suitable protocol to collect information on the subject regarding disease prevalence, social and ethnic attitudes of the community under survey, along with 'cost of sickness' to the individual and community, as well as the 'cost benefit' aspects of the proposed disease control programme.

The first step is to ascertain the community's need in respect of the disease control and the line of investigation on this aspect is depicted below:.

'Felt need' gradation → The percentage of total needs of the community which are perceived by its members

↓

Demand gradation → Identify need(s) requiring attention and make placement of the disease on the basis of the percentage of the felt needs of the community as expressed to the public health authorities for immediate action.

↓

Utilisation → Interaction of demand services provided *vis-a-vis* acceptance by the community

'Community Need' Oriented Method of Fixing Priority of a Disease Control Programme

Other basic questions to be resolved are:-

i. whether the technology available currently would reduce, control or alter disease pattern in the community ?

ii. what will be the cost of such a control organisation *vis-a-vis* 'cost of the disease' or loss to the nation on account of the disease ? While planning the disease control programme, the main deciding factor should not be 'economic aspect' alone but the moral, ethical and health-care components should also get equal consideration.

iii. On face value, the disease control programmes appear to be costly and require a huge financial outlay but considering the per capita expenditure on such measures, they are much cheaper than the treatment of a large number of persons who suffer from communicable diseases. In India, annual per capita expenditure on malaria during the first three decades of NMEP (population protected under the vertical programme) ranged between Rs. 0.42 and Rs. 1.71 per annum; on average it was Rs. 0.87. This is definitely much cheaper than the cost of the disease to the individual and estimated loss to the national economy.

RESOURCE MOBILISATION

Further, it is necessary to look into the availability of resources and their mobilisation. Resources can be drawn from different quarters. Active community participation and bottom up planning inputs at local level by the community should assume very high priority. Different sources which can contribute to financial input are:-

i. contribution by the individual or the family in cash or in kind i.e. labour input.

ii. voluntary contribution of resources from the community itself. Organised community may contribute either in cash or kind towards implementation of the programme.

iii. the industrial, agricultural and voluntary organisations can also help in disease control programme by appropriate contribution in cash or kind.

iv. bilateral and international assistance in cash or kind.

v. the national Government Revenue is usually the main source of funding of such programmes.

Policy decision taken on the implementation of disease control programme sometimes overlooks the technical aspects in view of the overall national goals.

However, while deciding the appropriation of resources for the disease control programmes, the amount by which the total allocations to health programme would increase should be considered by a team of Economists, Social Scientists and Health Experts. **Decision making should take into consideration the quantity and quality components as regards to the distribution of resources for health development in the country and for the disease control within the health sector.**

The fact remains that each communicable disease has its own priority on the basis of cultural and economic reasons related to the community. In some areas, it may be advisable to accord priority for control of Schistosomiasis or Chaga's disease or Visceral leishmaniasis over malaria. For example, in India in the Gangetic plains of Bihar, Visceral leishmaniasis should get priority over malaria control operations because transmission of malaria in these areas is at a very low level and even 2-3 years of control operation from 1958-59 to 1961-62 resulted in practically wiping out malaria from this area and it has not yet staged a comeback. However, on the other hand, Visceral leishmaniasis, which was controlled during the above period, has come back in a big way after a lapse of 20 years.

UTILISATION OF HEALTH SERVICES

It is important to remember that in rural areas, especially in tribal areas, utilisation of health services by the rural community is not necessarily improved by providing more outlets such as PHC, Subcentres, or even by upgrading the facilities available at the existing health outposts. The 'cost effective' or 'cost benefit' ratio is not likely to be altered by these measures.

On the other hand, the utilisation of health services usually involves improvement of socio-

economic and cultural demand for the health care by the community. A large number of factors govern the response of rural masses towards utilisation of health facilities. Apart from the physical distance between the village and PHC, availability of transport facilities in the area, as well as the financial expenditure likely to be incurred by the consumer also modify the utilisation pattern. A significant improvement in the above facilities can increase utilisation of health services in the area. Another facet which is more difficult to surmount pertains to the attitude and cultural values assigned by the rural masses to modern medicine as compared to the alternative system of treatment of diseases prevalent within the cultural unit. The local herbal medicines are ingrained in the local culture; they are cheap, and sometimes very effective and thus it may be difficult to motivate the tribal and rural masses to utilise the facilities given under the modern system of medicine through PHC services. To improve acceptance it may be necessary to demonstrate conclusively the advantages of modern medicine and techniques in control of local diseases. **It is suggested that rectifying the existing geographical maldistribution or opening up of new primary health centres with a view to bring the health posts nearer to the door step of the community should be considered only after studies on Knowledge, Attitudes and Practices have been carried out in the tribal areas and corrective measures suitable to the local situation have been incorporated to make the rural health delivery system more acceptable and attractive to the individual and masses.**

COSTS AND BENEFITS

A lot can be said about the 'cost-benefit', 'cost-effectiveness' and 'cost efficiency' aspects of the disease control. It is not possible to discuss in detail all the aspects. However, some factors are considered while fixing the priorities of a disease control programme such as:

a. The technical problems related to the control measures.

b. Social and health inputs.

c. Particulars and demand of health services.

d. Interdisciplinary factors.

e. Health-related economic consequences of the disease.

f. Difference in economic status likely to accrue by health intervention measures to the individual.

g. Effect on national economy connected with the health problem and gains likely to the nation on implementation of preventive and control measures.

IMPACT OF MALARIA ON THE INDIAN POPULATION

A lot of work has been done on the problem of malaria, its impact on economic and social fields on the Indian population and the likely cost and benefit of the programme. A monumental work of compilation was undertaken by J.A. Sinton in 1935. He estimated a loss of Rs. 7,500 million per year to the Indian economy on account of malaria. While arriving at these estimates, he had taken into consideration the following factors to justify the urgency of control activities:-

- Morbidity caused directly by malaria.

- Morbidity caused indirectly by malaria which is related to factors such as reduction in general health, lowered vitality leading to intercurrent infections, lower recuperative power due to high nutritional requirement during and after the disease.

- Effect of malaria on physical and intellectual development of the community.

- Effect of malaria on life expectancy and reduction in the level of productive group of population.

- Effect of malaria on birth rate due to abortion and premature deliveries.

- Effect of malaria on infant mortality and premature deaths.

- Effect of malaria upon social, intellectual and political advancement of the nation in which examples of countries like Greek, Italy and British Guyana were quoted to draw similar conclusions

on overall effect of the disease on Indian population.

- Effect of malaria on agriculture, industry and transport.

'COST BENEFIT' ASPECTS OF INDIAN MALARIA PROGRAMME

A few studies have been carried out on **'cost benefit'** of Malaria Control/Eradication Programme. A study was conducted by the Indian Institute of Management, Ahmedabad and the authors traced the history of malaria in India, and its impact on national economy in pre-control era as reported earlier by Sinton and others. They also studied in detail the impact of control/ eradication programmes on disease prevalence and expenditure incurred by the country on its implementation. While assessing the 'cost benefit ratio' they had considered a large number of epidemiological and economic parameters. They have concluded that **'each rupee spent on Malaria Control/Eradication Programme since 1953-54 has brought in a benefit of Rs. 9.27 to the nation'.** The authors have limited their studies to computing the **'cost benefit ratio'** in terms of **'total disease cost'** estimates at constant prices (i) with NMCP/NMEP, (ii) without NMCP/NMEP and further estimating the monetary benefits accrued on account of implementation of NMCP/NMEP. They went on to calculate the cumulative benefits and cost, thereafter worked out 'cost benefit ratio'. The above study did not take into account the total impact of NMCP/NMEP on community health and their life style or other collateral benefits resulting in availability of a larger healthy labour force which could take up activities directly related to national economic development. At current prices the benefit accrued to community is given at Annexure: 1.1.

The investigators observed that during the period 1953-54 to 1957-58 i.e. control phase, the programme administration and the staff gradually expanded all over the country. As a consequence while there was increasing programme expenditure, the benefit increased at faster rate resulting in gradual increase in 'benefit cost ratio' year after year. However from 1959-60 to 1961-62 decline was recorded in 'cost-benefit ratio'. In other words, increase in funds was higher than the benefits. During the third phase i.e. 1962-63 to 1967-68, there was general decline in the programme expenditure, though there was some increase in malaria incidence during this period. Thus the decline in funds tended to record the increasing value of 'benefit cost ratio' which was an artefact. Similar picture emerged during the period 1968-69 to 1976-77. The study, therefore, concluded that the maximum possible benefits of NMCP/NMEP were achieved way back in 1958-59.

Some experts do not agree with this observation because as a result of control measures there was a continuous decline in the Slide Positivity Rate (SPR) upto 1965 indicating that malaria case load in the community showed a constant downward trend upto 1965 resulting in yearly increase in 'cost benefit'. It is also stated that subsequent efforts, though have been able to bring about the positive benefits, do not appear to be commensurate with the programme expenditure. Such conclusions may alarm the administrators who may think whether it is advisable to continue to incur such a large expenditure on malaria control, if further inputs result in low 'benefit cost ratio'.

If observed rationally, it will be seen that the expenditure had resulted in giving other collateral benefits to the nation on health and economic fronts. To quote a few, Kala-azar in the Gangetic plain was practically eradicated although it has staged a comeback after 20 years over last 38 years (i.e. since 1958). Plague outbreaks or even sporadic cases were hardly observed or reported from India. Only in 1994 an epidemic of plague occurred due to complacency of health administrators.

EVALUATION

'Cost benefit' and 'cost effective' analyses are two primary tools for evaluation of a disease control programme. The programme evaluation should be carried out at national or regional level depending on the geographical distribution of disease, control plans and their implementation.

Myrdal (1968) focussed the attention to the complicated nature of measurements in monetary terms of the benefits accruing as a result of programme implementation in 'education' or

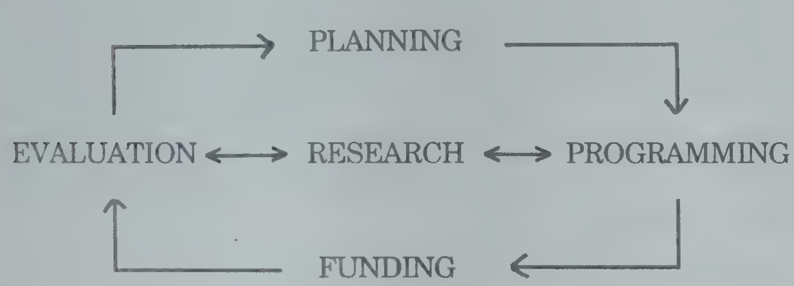
'health' sectors, because immediate or long-term benefits of such activities cannot be measured with a precise degree of certainty.

To facilitate programme evaluation, it is necessary to define precisely in physical and financial terms, the short and long-term objectives and yearly or seasonal targets under each activity of the disease control plan.

Further a monitoring system should be built within the programme organisation, so that reliable data on different programme activities can be collected and utilized for concurrent and consecutive assessment of their impact on the disease epidemiology.

It is also necessary that such an assessment should be carried out periodically to ascertain that the programme is being implemented according to the plan and the prescribed targets are being achieved.

Evaluation of a disease control programme is a much bigger exercise directed towards getting meaningful analysis for ascertaining the need for continuing the control activities in their present form or bringing in any change in the strategy. It also provides justification for allocation of funds. Although periodic, it should be a continuous exercise. This can be represented as under:-



Timing of Evaluation

It is necessary to time such an exercise at suitable intervals. These would depend on many factors, most important being the epidemiological characteristics of the disease related to its transmission like (a) reproduction rate - for example reproduction rate of malaria is much higher than the reproduction rate of filaria or kala-azar. (b) Incubation interval - the incubation interval in case of malaria is anywhere between 22 and 35 days, while in filaria it may be one to two years and likewise is the case with kala-azar. Thus, the impact of control measures in case of malaria will be apparent more quickly within a year, while in case of filaria, the disease rate or microfilaria rate do not show variation so soon. Therefore, the evaluation of filaria control programme should be taken at longer intervals after the implementation of control measures as the impact of these will not be discernible early. The dynamics of transmission and disease pattern would indicate the time frame for the evaluation of the disease control programme impact on its epidemiological distribution.

Lastly it is reiterated that the National Government while selecting control technology out of the several options available or those who wish to change control operations by innovative methods such as replacing use of adulticides with antilarvals or bio-environmental methods etc. should ensure that the alternative control operations available are technically sound and suitable for implementation through local health infrastructure. The 'cost - effective' and 'cost - benefit' studies should be conducted to evaluate suitability of different options including current methods in use. This study should be carried out by accredited HEALTH ECONOMISTS and SOCIOLOGISTS. The team should also have experts in management and malariology. The malariologist connected with the existing control programme or a researcher advocating innovative technology should not be an active member of the team. In this respect local experts should be preferred than the experts from outside the country because of difference in the socio-cultural background of the investigators *vis-a-vis* the community. Their role should be limited to providing relevant information or advice. This approach is suggested with a view to obviate any personal bias creeping in the final report. The 'cost-effective' and 'cost-benefit' studies should also take into consideration the existing health infrastructure and its modification, if any, required for changing the control approach and the capability of the Government to bring in such changes within the time frame proposed for implementing the control operations.

Annexure: 1.1

COST - BENEFIT ANALYSIS OF MALARIA CONTROL OPERATIONS IN INDIA

An attempt is made to justify the expenditure incurred by Government of India on malaria control operations. The justification is presented indirectly by calculating the cost of treatment of a malaria case at 1994 prices. Only essential items have been considered while computing the cost. The estimates include the expenditure likely to be incurred by an individual or his family on treatment of a malaria patient. Having calculated the expenditure incurred by an individual on treatment of a malaria episode, endeavours have been made to estimate malaria cases in the country if control operations were not implemented and this cost is reflected in respect of the total estimated malaria incidence in the country. In this manner the quantum of expenditure has been calculated. This expenditure would have been incurred by individuals or their families, had there not been malaria control operations in the country.

In pre-eradication days, i.e. before the organised countrywide malaria control operations were taken up, it was estimated that the malaria morbidity was approximately 75 million cases in a population of 343.11 million. In other words 21.85 per cent of the population suffered with at least one episode of malaria each year. The 1994 estimates of malaria incidence without control operations are based on these figures.

It may be argued that the endemicity levels in the country have changed due to developmental activities over the last 50 years and estimates based on the basis of pre-control endemicity patterns may not be applicable in the present situation. If the current socio-economic conditions are examined, it is evident that **malaria transmission potential** instead of declining might have actually increased in some areas on account of increased irrigation facilities and population migration for developmental projects. At the project sites, the labour today is more vulnerable to malaria infection at work site when compared to the risk in their native village(s). The recent example of Visakhapatnam Steel Plant is enough to highlight the point. Before the construction was taken up in this area, the malaria cases were only 257. During the construction phase of the Steel Plant, the highest number of cases recorded was 10,661 which shows that there was a rise in incidence by over 40 fold in this project area. A large number of such examples can be given as similar situation was observed in almost all other major industrial and other water resource development projects.

The increase in irrigation potential in the country has also played an important part in changing the endemicity level of different areas. Haryana and Punjab were traditionally epidemic prone areas. During inter-epidemic period, the malaria incidence was very low in these States. Due to increased irrigation and extensive agricultural activities, use of high yield variety of seeds requiring more irrigation, multiple cropping pattern, etc. the endemicity levels in these States have increased over the last 50 years. The API in these States has been constantly high in 1994. The API was 1.62 and 0.71 in Haryana and Punjab respectively showing that at present these areas are more or less low-endemic areas for malaria. A similar situation is encountered in almost all States and Union Territories, as very large tracts of forested areas have been cleared for agriculture and highly efficient irrigation facilities have been provided. Now-a-days these areas show higher level of endemicity of malaria.

In the past, malaria was considered a rural problem and urban areas were presumed to have had very little malaria. But over the last three decades there has been tremendous increase in malaria incidence in urban areas. Madras City alone contributed 44 to 72% of the total cases of Tamil Nadu during the period from 1984 to 1994. Therefore, it has now become essential to take into account malaria incidence of urban areas while computing socio-economic impact of malaria in the country.

The above statements are directly proved by

very high malaria incidence recorded in almost all focal outbreaks and epidemics encountered during recent past. The epidemics were due to breakdown of malaria control activities including case detection, treatment and transmission control operations. The morbidity and mortality figures favourably compare with pre-eradication endemicity. Thus the comparison and estimates of malaria incidence based on pre-control incidence of malaria in India seem to be valid even today.

A. Estimates of malaria incidence in 1994 if there were no control operations.

(Fig. in million)

Year	Population	Estimated malaria incidence	Estimated malaria deaths
1947	344.11	75	0.80
1994	879.00	191.58	2.04

B. Break-up of 1994 estimated malaria cases -specieswise in Table A into Urban and Rural.

(Fig. in million)

	P.vivax	*P.falciparum*	Total
Rural	76.46	55.13	131.59
Urban	53.89	6.10	59.99
Total	**130.35**	**61.23**	**191.58**

C. Malaria cases recorded during 1994 by malaria surveillance system under NMEP.

(Fig. in million)

	P.vivax	*P.falciparum*	Total
Rural	1.151	0.830	1.981
Urban*	0.203	0.023	0.226
Total	**1.354**	**0.853**	**2.207**

*The urban cases given above are recorded in a population of 74 million covered under Urban Malaria Scheme. There are other urban areas from where the reports are not directly received at National Directorate but are reported by the district officers after including these within the rural incidence figures.

D. Difference in Rural and Urban cases in Table B and C, i.e. number of malaria cases prevented due to malaria control activities.

(Fig. in million)

	P.vivax	*P.falciparum*	Total
Rural	76.460	55.13	131.590
	(-) 1.151	(-) 0.83	(-) 1.981
	75.309	54.30	129.609
Urban	53.89	6.10	59.990
	(-) 0.203	(-) 0.023	(-) 0.226
	53.687	6.077	59.764
Total	**128.996**	**60.377**	**189.373**

Quantified financial loss to an individual and his family at 1994 prices

I. Uncomplicated Case of Malaria

		Expenditure per episode (Cost in Rs.)
Cost of Antimalarial Drugs		
i.	Chloroquine	5.00
ii.	Antipyretics	5.00
iii.	Long acting Sulfa and Pyrimethamine combination	5.00
iv.	Tonic supplement	15.00
		30.00

Expenditure on Medical Advice for average three consultations

Rural @ Rs. 10/- each	30.00
Urban @ Rs. 25/- each	75.00
Transportation to and fro	30.00

Nursing Cost by an Unskilled Person-part time for 4 days

Rural @ Rs. 10/-	40.00
Urban @ Rs. 20/-	80.00

Cost of Special Diet for 7 Days

Rural @ Rs. 5/- per day	35.00
Urban @ Rs. 10/- per day	70.00
Rural	135.00
Urban	255.00

Total Expenditure on Treatment of a Single Patient

Rural	165.00
Urban	285.00
Loss of wages for 4 days in case of an unskilled person @ Rs.50/- per day	200.00

Total loss per episode to an individual

(in case of skilled workers of urban area in industry, business, administration etc., the loss will be higher).

Rural	365.00
Urban	485.00

Note:-

i. The cost of medicines includes both long acting Sulpha plus Pyrimethamine and Chloroquine because most Medical Practitioners prescribe both drugs simultaneously for treatment of malaria.

ii. Loss of wages and nursing care cost are calculated for 4 days only as some of the uncomplicated cases during fever free period may attend to their normal work.

II. Complicated Case of Malaria

Expenditure on a complicated malaria case requiring at least 10 days hospitalisation and special nursing care may be anywhere from Rs. 500/- to Rs.2,000/- depending on the level of special care required. Average may be taken as Rs. 1,500/- per case. This includes hospital cost even if it is a Government Hospital along with other elements like drugs, diet, transport, etc.

TREATMENT COST OF COMPLICATED MALARIA CASES

(only 0.5 to 2% *P.falciparum* cases have serious complications)

(Fig. in million)

Rural @ 700/- per case	0.689x700	Rs. 482.30
Urban @ 2285/- per case	0.076 x 2285	Rs. 173.66
Total		Rs. **655.96**

TREATMENT COST OF UNCOMPLICATED MALARIA CASES

(Fig. in million)

Rural @ 365/- per case	128.92 x 365	Rs. 47,055.80
Urban @ 485/- per case	59.688 x 485	Rs. 28,948.68
Total		Rs. **76,004.48**
Grand Total		Rs. **76,660.44**

The calculations above indicate that approximately Rs. 76,660/- million are saved every year due to malaria control operations now being implemented in the country.

Even if it is presumed that malaria incidence in the country is actually 10 times higher than reported i.e. instead of it being 2.2 million (on the basis of an average of high and low estimate by MRC of ICMR in 1991) it is placed in the region of 25 million cases per year the cost may be lowered by Rs. 10,000/- million. This sum when reduced from Rs. 76,600/- million gives the savings of about Rs. 66,600/- million.

According to an estimate by Director, MRC - ICMR, Delhi, the total expenditure incurred on malaria control in India was nearly Rs. 3467.90 million which included Central and State budget

allocation of NMEP in 1994 and the estimated expenditure by municipal bodies. Defence organisations, Railways, Tea Gardens and other non-governmental agencies have their own malaria control operations and they allocate their own funds for it. The break-up is given below:

		(Rs. in million)
Central budget 50:50 sharing 1994		804.6
State share* 50:50		804.6
Estimated additional expenditure		
by urban bodies -	Central assistance	93.70
	£-Local body expenditure	925.00
# Expenditure by Defence, Railways, Public Sector industries, etc.		80.00
# Expenditure by public & private sector organisations such as projects, tea gardens, private industries, etc.		660.00
Research		100.00
Total		**3467.90**

* Some of states' expenditure incurred by allocations under Non-plan quantum is difficult to assess.

£ Expenditure by local bodies on urban population is based on per capita expenditure incurred on Urban population of Delhi @ Rs. 12.50 projected under Urban Malaria Scheme (74 million). The total expenditure works out to Rs. 925.0 million which is a higher estimate because in smaller towns per capita expenditure will be much less.

Figures quoted by Malaria Research Centre of Indian Council of Medical Research, Delhi.

Thus it can be calculated that for every Rupee invested in malaria control has produced a direct return of Rs. 22.10.

The above amount does not include the hidden but a huge saving on account of the labour days (years) saved which is many times higher than the direct saving to an individual. It has an element of labour days saved, cost of goods which could be produced by utilising these labour days and has quite a sizable impact on Gross National Product.

The estimates of labour days saved come to 1328.75 million man-days per year.

An expenditure of Rs. 3.85 per capita per annum is incurred by the Govt. of India and other organisations. To this must be added the expenditure incurred by the general community on the treatment of malaria cases. On the basis of MRC estimates of 25 million cases per annum (ten times the incidence recorded by NMEP), the expenditure per capita per annum works out to be Rs. 3.33

Thus the total expenditure incurred on morbidity due to malaria works out to be Rs. 7.18 per capita per annum.

SELECTED REFERENCES

1. Herrin, A.J. and Rosenfield, P.L. (1988): Economics, Health and Tropical Diseases, published by University of Philippines School of Economics.

2. Aseno-Okyere, W.K. (1994): Socio-economic factors in malaria control. *World Health Forum*, **15**:265-268.

3. Bentley, C.A. (1911): Report of an investigation into the causes of malaria in Bombay, and the measures necessary for its control. Government Central Press, Bombay.

4. Bradley, D.J. (1978): Prevention of disease in the tropics. Questions in health economics. *Epidemiology and Community Health*, **33**: 66-73.

5. Conly, G.N. (1975): The impact of malaria on economic development. A case study. Scientific publication no. **297,** Pan American Health Organisation, Washington, D.C.

6. Mills, A. (1994): The economics of vector control strategies for controlling tropical diseases. *Am.J. Trop Med. Hyg.*, **50**:151.

7. Myrdal, G. (1968): Asian Drama. Penguine Books Ltd., Harmondsworth, Middlesex, England, p. 293-302.

8. Phillips, M., Anne Mills and Christopher Dye (1993): Guidelines for cost-effectiveness analysis of vector control. PEEM Secretariat, *PEEM Guidelines Series 3, World Health Organisation, Geneva, WHO/CWS/* 93.4, p.1-192.

9. Ramaiah, T.H. (1980): Cost benefit analysis of malaria control and eradication programmes in India. PSG monograph No. ***26***, Public systems group Indian Institute of Management, Ahmedabad, p.1 78.

10. Russel, P.F. and Menon, M.K. (1942): A malario-economic survey in rural South India. *Ind. Med. Gazette*, **77**:167-180.

11. San Pedro, C. (1967): Economic costs and benefits of Malaria eradication, Philippines. *J.Public Health*, **12**:5-24.

12. Senior-White, R. and Newman, C.D. (1932): Studies in Malaria as it affects Indian Railways. Technical Paper. Calcutta : Central Publication Branch.

13. Sharma, V.P. (Unpublished): Malaria: Cost to India and future trends. Malaria Research Centre, Delhi-110 054.

14. Shepard, D.S., Eting, M.B., Brinkmann, U. and Sauerborn, R. (1991): The economic cost of malaria in Africa. *Trop. Med. Parasitol.*, **42**: 199-203.

15. Sinton, J.A. (1935): What malaria costs India, nationally, socially, and economically. *Recd. Mal. Surv. India*, **5**:224-264 and **5** :413-489.

16. World Bank (1993): World Development Report. Investing in health World Development indicators, Oxford University Press, Oxford. p. 1-329.

2

MEASUREMENT OF MALARIA

INTRODUCTION

The assessment of malaria endemicity is a prerequisite for planning malaria control operations in an area. The properly analysed and classified disease prevalence in an area helps in formulating an appropriate control strategy. The selection of most effective control methodology, the size and the administrative structure of the organisation required in implementing the selected strategy is decided on the findings of malaria endemicity measurements.

MALARIA SURVEYS

The malaria endemicity of an area can be ascertained by conducting a malaria survey or collecting data on malaria morbidity through the General Health Services. Information in respect of both urban and rural areas should be collected in the same time frame.

In the past, malaria surveys were conducted to ascertain the endemicity of the disease in an area where General Health Services, especially Rural Health Services were not well developed or were not capable of collecting data on malaria morbidity.

The malaria survey is still the method of choice for collecting data on malaria endemicity in a developing country which does not have adequate infrastructure under the Rural Health Services.

The countries, where the Rural Health infrastructure under the Primary Health Care System has been established, such as in India, there is no need to carry out classical malaria survey. The prevalence of the disease can be ascertained from the data collected through the Rural Health Services. From the records of surveillance operations, annual parasite incidence (API), the slide positivity rates (SPR), proportion of *P. falciparum* to total malaria incidence, number of severe and complicated malaria cases treated in hospitals and number of deaths in microscopically confirmed *P. falciparum* cases can be used to determine malaria endemicity levels. These parameters are utilised for planning malaria control strategy or for modification of the existing control operations.

In a situation where **malaria survey** is deemed essential to collect accurate data on malaria, it **should be carefully done covering all strata of the community**. This is also applicable when information is collected through Rural Health Services. The malaria surveys should be designed on sound statistical basis keeping in mind that the disease is exclusively a local phenomenon and its endemicity varies from place to place.

However, the idiom 'there is unity in diversity' is also applicable to malaria because in spite of its

focal nature, the epidemiological profile, malaria transmission dynamics and disease prevalence are more or less similar in areas having identical climatological and environmental profile.

The **components** of malaria survey are as follows:

Spleen Survey

Spleen survey is the oldest method of measuring malaria endemicity level in a community. Although crude, it is the quickest method to find out malaria prevalence in the community. It also gives a fair idea about the intensity of the disease to which a local population was exposed in the past. **The degree of splenic enlargement should not be confused or equated with the level of immune status of the patient. Nevertheless spleen enlargement does indicate that 'how often' and 'how long' a person had been exposed to malaria infection in the past.**

i. Limitations

The only drawback in measuring malaria endemicity through the study of splenic enlargement is due to the fact that there are several other diseases prevalent in tropical areas which also cause splenomegaly. To ensure the accuracy of malaria endemicity data, the patients showing splenomegaly due to these diseases should be excluded from the malaria surveys.

Some of the tropical diseases which commonly show splenic enlargement are given below:

Causes of Spleen Enlargement

Tender Enlargement	Non-tender Enlargement
i. Typhoid	i. Malaria
ii. Relapsing fever	ii. Visceral Leishmaniasis
iii. Trypanosomiasis	iii. Chronic Myeloid Leukemia
vi. Typhus fever	iv. Thalassaemia
v. Brucellosis	v. Sickle cell anemia
	vi. Leprosy
	vii. Leptospirosis
	viii. Intestinal Schistosomiasis*
	ix. Hydatid disease
	x. Bartonellosis*

* These diseases are not common in India

ii. Splenomegaly in Malaria

In the early stages of *P.falciparum* and other acute plasmodial infections with high parasitaemia in the peripheral blood, the spleen enlargement is tender but later on during the chronic stage of the infection, it becomes non-tender.

The other aspect which gives a unique dimension to splenomegaly in malaria is the fact that in endemic areas it is more widespread in the community than the splenic enlargement due to other diseases mentioned above. Therefore, the persons included in malaria survey should be asked about the history of intermittent fever. This symptom is typical to malaria infection and can be used as a quick technique for the differential diagnosis of splenic enlargement.

In a non-endemic but receptive area, the spleen enlargement is observed, in a larger group of persons in the community who were exposed to malaria infection during the epidemic period. **The spleen enlargement in an individual occurs if he experiences parasitaemia for a period exceeding two weeks.** Thereafter the degree of spleen enlargement depends upon the duration of exposure and severity of parasitaemia. The spleen will continue to grow in size in cases who do not receive any treatment or were given incomplete chemotherapy for malaria during the fever episodes. The situation described above is usually seen in tribal population living in inaccessible hilly regions far away from the peripheral rural medical facilities. **If a malaria case is given treatment with appropriate antimalarial right after the first episode of fever, there will be no splenic enlargement.**

The detailed pathological process of spleen enlargement can be referred in any text book on pathology. It has been observed that most of the cellular debris of the RBCs and phagocytosed parasites are ultimately entrapped in the splenic pulp. This pathological process in turn triggers the process of hyperplasia in the splenic pulp resulting

in splenic enlargement.

From the above description, it can be visualised that in a hypoendemic or epidemic prone area, after a malaria outbreak, most of the malaria cases (those who did not receive appropriate antimalarials within a period of two weeks) would show only slight enlargement of spleen. On the other hand, in meso and hyperendemic areas, the splenic enlargement of varying degrees is seen in the local population. The size of the spleen depends on the length of the patient's exposure to malaria infection. In those individuals, who are repeatedly exposed to malaria infection over several years, the splenic enlargement may sometimes extend below the umbilicus.

Whenever there is a delay in treatment and the parasitaemia persists for a period of over two weeks, easily palpable splenic enlargement is observed but after chemotherapy leading to parasitic cure and in the absence of reinfection, the splenic enlargement gradually regresses. This regression takes anywhere from 3 to 6 months. By the end of this period the enlargement may completely disappear. Thus in endemic areas, where the parasite infection continues more or less uninterrupted for many years, large number of persons in the local population, especially children, will be found positive for splenic enlargement.

The general opinion among the experts is that if the spleen rate in the community exceeds 5%, presence of endemic malaria in the population should be suspected because malaria is the only disease which under suitable conditions produces very large number of infections in the community. The high spleen rate in some areas where extensive chemotherapy with Chloroquine has been administered to the fever cases or community, may indicate the presence of resistant strain of *P.falciparum* in the areas. The infection with *P.falciparum* may show remission of clinical symptoms but may continue to harbour low grade parasitaemia. This parasitaemia results in splenic enlargement.

iii. Measurement of Spleen Enlargement

This method of measuring malaria endemicity in the area was first used by **Dumpster in 1848 in India.** Later on, an arbitrary classification of spleen enlargement was suggested by Hackett, and it has been internationally accepted. The degree of splenic enlargement is used to classify malaria endemicity of an area.

The Hackett's method for classification of enlarged spleen is as follows-

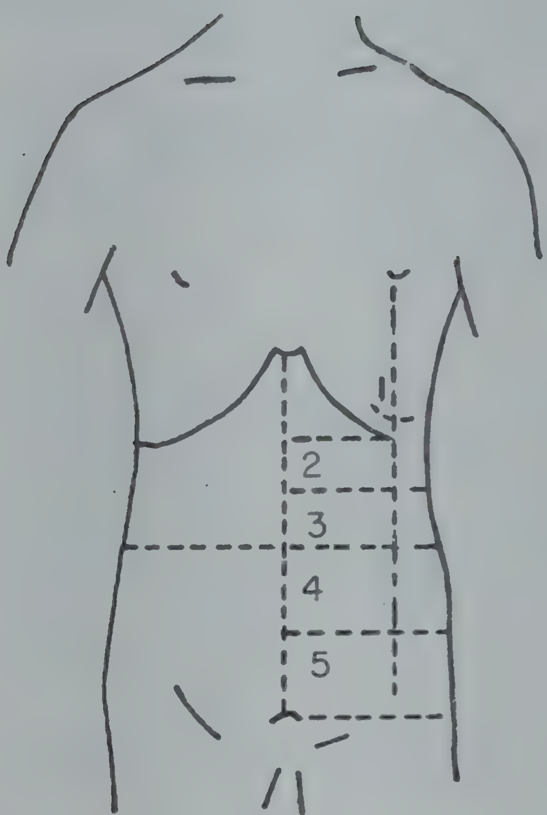
Class of Spleen	Description
0	Normal spleen not palpable even on deep inspiration.
1	Spleen palpable under the costal margin, usually on deep inspiration.
2	Spleen palpable below the costal margin, but not projecting beyond a horizontal line half way between the costal margin and the umbilicus, measured along line dropped vertically from the left nipple.
3	Spleen with lowest palpable point projecting more than half way to the umbilicus level but not below a line drawn horizontally through it.
4	Spleen with lowest palpable point below the umbilicus level but not projecting beyond a horizontal line situated half way between the umbilicus and the symphysis pubis.
5	Spleen with lowest point palpable beyond the lower limit of class 4. (Fig - 2.1).

The measurement of malaria endemicity based on the spleen rate gives fairly accurate estimate of malaria problem in the community.

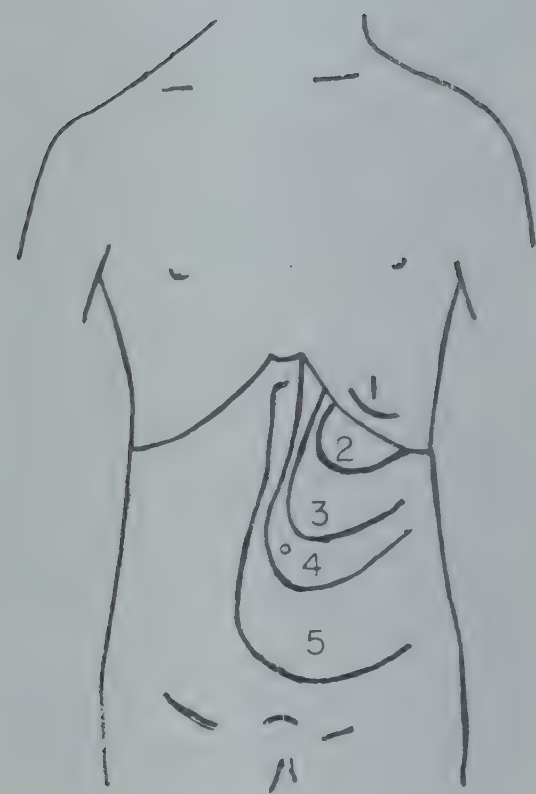
The spleen survey is the cheapest and quickest method of survey and does not require special instruments except the skill of the worker. A single person can carry out this survey.

iv. Spleen Palpation

While palpating the spleen, the patient is asked to lie down on his back, the examiner stands on the right side of the patient. The legs of the patient are bent at knees. He starts



Topographical reference lines for the five classes of enlarged spleens



Projection on the surface of the abdomen of the five classes of enlarged spleens

Classification of spleen sizes according to Hackett's method (WHO. 1963 Terminology of Malaria)

Fig- 2.1

palpating the spleen from the lower part of the left side abdomen and gradually goes upwards to the left costal margin till the spleen edge is felt. At the costal margin it is palpated during deep inspiration taken through an open mouth.

A class 1 spleen will be palpable only on deep inspiration. If the field conditions do not permit making arrangements for the patient to lie down, an alternative method is used where the examiner sits on a stool and the patient stands in front of him facing outwards .The examiner supports the chin of the patient with his left hand so that patient does not look down, because this action makes the abdominal muscles tense. Then the patient is asked to take a deep breath through open mouth. The examiner palpates the spleen with the right hand. Same technique is used in case of a patient in lying down position. **It is essential that spleen palpation should start from below the umbilicus because if the spleen enlargement is of class 4 or above, the examiner can miss the spleen edge and thus miss the diagnosis.**

The data collected on spleen enlargement can be used for calculating **Spleen Rates and Average Enlarged Spleen.**

CHILD SPLEEN RATE (CSR)-FORMULA FOR CALCULATION

$$CSR = \frac{\text{No. of children (2-9 yrs) with enlarged spleen}}{\text{No. of children (2-9 yrs) examined}} \times 100$$

The epidemiological significance - The spleen enlargement is used for estimating the quantum of exposure to malaria transmission in the past by the community. **The splenic enlargement is measured among children in the age group of 2 to 9 years.** This age group is selected because the young children do not have innate immunity to malaria. After an exposure to malaria, the immunity develops very slowly. The spleen hyperplasia occurs because it has to breakdown parasites and destroy RBCs into smaller molecules for recycling or excretion or elimination of the metabolic products. **At birth normally spleen is below the costal margin and enlargement cannot be measured with accuracy. By the second year of age spleen retracts under the costal margin.** Therefore, the spleen enlargement is measured in children of 2 years of age and above. With advancing age, the immunity develops and it modifies the rate of splenic enlargement. Because of this, the children up to 9 years are included in child spleen surveys.

The malaria survey data should be tabulated as below and thereafter it is used for estimation of Average Enlarged Spleen (AES).

Class of spleen	**Age groups 2 - 9 years Number of various classes found**	
0 (not palpable)	22	
1	32	1 x 32 = 32
2	14	2 x 14 = 28
3	5	3 x 5 = 15
4	3	4 x 3 = 12
5	2	5 x 2 = 10
Total	**78**	**97**

$$\text{Average enlarged spleen ;} \quad \frac{97}{56} = 1.73$$

The Average Enlarged Spleen (AES) index is calculated by multiplying the number of individuals in each class of enlarged spleen by the class of spleen. For example an average enlarged spleen from the data given above will be calculated as - 1 multiplied by 32 = 32, 2 multiplied by 14 = 28, 3 multiplied by 5 =15, 4 multiplied by 3 = 12, 5 multiplied by 2 = 10. The total comes to 97. The average enlarged spleen will be 97 divided by 56 (i.e. number of children showing enlargement of spleen) - 1.73 with 71.8% spleen rate indicating that this is a hyperendemic area. **The average enlarged spleen rates will be higher in holoendemic areas, although no specific criteria have been laid down.**

v. Description of Malaria Endemicity Based on Spleen Rates

During the first African Malaria Conference in 1950, malaria endemicity was described in terms of spleen rates. The following classification which

is a slight modification of 1950 criteria was adopted in 1958 by WHO :-

Holoendemic malaria-	with a spleen rate in the 2 - 9 years age group constantly over 75 per cent, and a low spleen rate in adults.
Hyperendemic malaria -	child spleen rate constantly over 50 per cent, adult spleen rate high (over 25%).
Mesoendemic malaria -	child spleen rate 11-50 per cent.
Hypoendemic malaria -	child spleen rate not exceeding 10 per cent.

Parasite Survey

As already mentioned, there can be several reasons for splenic enlargement. It is, therefore, necessary that the results of spleen survey should be confirmed by a parasite survey in the community. During parasite survey, the malaria incidence in infants, children and adults is ascertained and studied to assess the malaria endemicity of the area.

i. Infant Parasite Rate (IPR)

The infant parasite survey is carried out in the children of age group below 1 year (365 days). As the infant population is usually very small in the community, endeavour should be made to include all infants in the survey. The infant parasite rate (IPR) is calculated as follows:-

$$\text{IPR} = \frac{\text{No. of infants found positive for malaria parasite}}{\text{Total number of infants examined during blood survey}} \times 100$$

This is the single most important index. If the sample size is adequate, this parameter if calculated accurately, gives a great deal of information regarding malaria transmission in the area during the epidemiological year. **Normally infants do not have malaria infection at the time of birth. Only in very rare cases and in holoendemic areas the transplacental infection may occur in infants. In the first few weeks of life, the infant is free from malaria parasite. He becomes malaria positive 10 to 12 days after being bitten by an infective mosquito.** Therefore, the number of infants showing malaria parasite gives clear indication of the intensity of malaria transmission in the community. If the data on positivity in infants are analysed monthwise, the period of transmission can also be ascertained.

ii. Significance of Longitudinal IPR Studies

Sometimes a longitudinal survey of infant population is carried out. **In this study each infant is registered at the time of birth and followed for a period of one year. By this study transmission period in an area can be found out fairly accurate for the area.** During these longitudinal studies, the point of time when any of the infants in the cohort is found positive, the malaria transmission is deemed to have commenced 22 to 35 days prior to the date of positivity of the infant. In case the infant is positive for *P.vivax,* it is 22 days while in case of *P.falciparum,* it is 35 days. In the absence of malaria infection in the cohort of infants under the study it may be inferred that there was no or negligible malaria transmission during the epidemiological year. The epidemiologist can conclude that the area is either free of malaria or there was a very negligible malaria transmission. In case malaria control operations were being undertaken in the area, it could be concluded that they were able to interrupt the local transmission during the year of investigation.

In countries where the transmission period has been ascertained prior to implementation of control strategy the cohort studies on infant parasite rates are usually not necessary. Further, a decision to carry out a repeat cohort study will depend on factors such as, there has been a large scale environmental change in and around the locality, socio-economic activity has resulted in transmigration of people or large scale changes in breeding habitats of the vectors. If these types of changes are not observed in the locality, it will not be necessary to repeat cohort studies. A malariologist must know that these studies are most essential for unmapped areas where malaria control operations are contemplated.

iii. Child Parasite Rate (CPR)

Another component of malaria survey is the Child Parasite Rate (CPR). **In child parasite survey,**

children in the age group of 2 - 9 years are included in the sample. Care is taken to include both sexes irrespective of the fever status.Larger the size of the sample, more accurate are the estimates of malaria endemicity. The statistical random sampling technique is adopted to determine the sample size for child parasite survey. Focal nature of the disease distribution is considered while selecting areas to be surveyed. The selected sample should represent all ethnic and socio-economic strata of the society.

The Child Parasite Rate is calculated as under:-

$$CPR = \frac{\text{No. of children (2-9 yrs) found positive for malaria parasite}}{\text{Total no. of children (2-9 yrs) examined during blood survey}} \times 100$$

The Child Parasite Survey indicates the prevalence of malaria parasite and its distribution at a point of time in the population of the locality.

The proportion of enlarged spleens in the various age groups cannot be always taken as a reliable index to quantify the prevalence of malaria in the locality. In populations exposed to intense and nearly perennial transmission, for reasons not fully understood the adults acquire a considerable degree of immunity to malaria and yet show a high frequency of palpable spleens. For such areas a classification of malaria endemicity has been proposed (Metselaar & Van Thiel 1959) based on the parasite rate.

Hypoendemic - parasite rate in children of 2 - 9 years as a rule less than 10% (may be higher during some part of the year).

Mesoendemic - parasite rate in children of 2 - 9 years as a rule 11% - 50% (may be higher during part of the year).

Hyperendemic - parasite rate in children 2 - 9 years constantly over 50%.

Holoendemic - parasite rate in infants constantly over 75%, spleen rate in adults high (New Guinea type) or low (African type), parasite density declining rapidly between second and fifth year of life and thereafter slowly.

Limitations and Disadvantages of Malaria Survey

As indicated above, the classical malaria survey is relied upon to ascertain the malaria endemicity of the area where Rural Health Services are not in position or not adequately developed to generate the required information or the existing information is not qualitatively or quantitatively reliable.

The limitation of malaria survey is that **it gives malaria endemicity of an area at a point of time.** Only the spleen enlargement i.e. **spleen rates and average enlarged spleen give an approximate indication about the malaria transmission intensity in the area during the past epidemiological year/years. There are wide fluctuations in these indices on account of seasonality of malaria transmission in tropical countries.** Therefore, it become necessary to carry out repeated malaria surveys during a year to find out the malaria endemicity levels or distribution of malaria parasite in the community during pre, post as well as peak transmission periods i.e. every year 3 malaria surveys are carried out in areas with seasonal transmission of malaria.

In India, all areas fall in the above category, even in foothill areas of Himalayas and Western and Eastern Ghats or hilly ranges of Central India where the transmission period is longer and there are only small variations in parasite prevalence during different seasons. Therefore, three surveys covering the entire epidemiological year are necessary.

POINT OF TIME SURVEY DATA VERSUS LONGITUDINAL SURVEY DATA

In the Indian context, the infrastructure under the Primary Health Care System for rural areas is adequate to gather proper epidemiological data on malaria incidence. The data are continuous/longitudinal at fortnightly interval and give the parasite distribution in the community for each fortnight. The parasite incidence during the year is easily calculated from the surveillance data. Therefore, **there is no need to carry out fresh malaria surveys in any part of India to ascertain malaria endemicity of the area, provided the Rural Health Services are geared up and utilised**

properly for malaria surveillance at fortnightly intervals. The surveillance data give more accurate estimates of malaria endemicity, magnitude of malaria transmission and parasite distribution in different segments of the community including the parasite distribution by age, sex, etc. These parameters if utilised properly give a more reliable insight on malaria epidemiology of the area and help in formulating proper control measures.

OPERATIONAL AND PARASITOLOGICAL INDICES UNDER NMEP

Under the Indian Màlaria Eradication Programme, during the last year of the attack phase, a surveillance organisation was established to carry out fever surveillance all over the country at fortnightly intervals. The fortnightly surveillance was carried out through domiciliary visits by the surveillance workers in their area depending on the terrain and population density. The surveillance section allotted to one surveillance worker had a population of 8,000 to 10,000. The surveillance worker during his visits collected blood smears from all fever cases and cases with history of fever in between his visits. **From the data, ABER is calculated i.e. Annual Blood Smear Examination Rate. In addition to this, a Monthly Blood Smear Examination Rate (MBER) is also calculated. The method of calculation is:-**

$$\text{ABER} = \frac{\text{No. of blood smears collected during the year}}{\text{Population covered under surveillance}} \text{ X } 100$$

$$\text{MBER} = \frac{\text{No. of blood smears collected during the month}}{\text{Population covered under surveillance}} \text{ X } 100$$

In both cases i.e. ABER and MBER the denominator is common because the entire population is covered during each fortnightly domiciliary visit. ABER is the cumulative sum of monthly rates during the year.

While computing ABER or MBER, blood slides collected by all agencies are taken into account i.e. blood smear collections through ACD, PCD, FTD or any other voluntary agency during the same period.

Number of blood smears collected and examined during a mass survey and their results should not be included while calculating ABER or MBER or other parameters.

i. Validity of ABER

Malaria surveillance presumes that every malaria case will present itself with the symptom of fever at some point of time during the course of infection. Therefore, if all fever cases occurring in the community are kept under surveillance over a period of time and their blood smears are examined for malaria parasite, the total parasitic load in the community can be measured. However, there are some exceptions. Some of the malaria patients who give history of fever during the past fortnight but do not have fever at the time of blood smear collection may not show microscopically detectable parasitaemia in the peripheral blood. On the other hand some afebrile persons can be positive for malaria parasite. On account of operational difficulties it is not possible to collect blood smears from fever cases on the first day of the episode. Therefore, for operational as well as technical reasons fortnightly surveillance is done. In the later part of the eradication programme, in most of the Indian villages the Fever Treatment Depots (FTDs) were established. These FTDs collected blood smears from fever cases who reported to them and gave Chloroquine as presumptive treatment for malaria to all these cases. **It was found that by adding these voluntary agencies, surveillance status of malaria case detection improved as community coverage was more extensive.**

The level of ABER depends on the fever rate in the community. In tropical countries, the fever rate in the community fluctuates widely from month to month and year to year. These fluctuations are due to other viral and bacterial infections prevalent in the area. All these diseases have seasonal distribution pattern in the community. **For accurate estimates of malaria endemicity, the blood smear examination rate especially the MBER should be equal to fever rate of the month in the community.** Therefore, it is necessary to ensure that all persons having fever during malaria transmission months are included in the total blood slides examined during the year.

The MBER norms of 0.8 per cent during non-transmission season and 1.2 to 1.5 per cent during transmission season were laid down in the Indian Malaria Eradication Programme. Several studies have shown that patients memory for a fever episode is very accurate for a week and thereafter the fever history becomes inaccurate with passage of time. Therefore, during surveillance operations at monthly intervals larger number of fever cases are missed. In India after the surveillance activities were handed over to General Health Services, the surveillance failed to give a correct epidemiological picture of malaria prevalence in the area as it was carried out at monthly intervals. Later on when the Primary Health Care System was strengthened by introduction of Multipurpose Worker Scheme (MPW) in the year 1978-79, domiciliary visit at fortnightly interval was reintroduced in all rural areas of the country. In difficult terrain and in areas where there were/are vacancies of MPW, a provision of FTD was made, resulting in considerable improvement in Blood Smear Collection from fever cases.

In countries where well organised rural health services exist with adequate number of **governmental personnel as well as volunteer posts, it is feasible and technically justified to have fortnightly blood smear collections from the fever cases. Technical justification for a fortnightly surveillance is based on transmission dynamics of malaria, the incubation interval in case of *P.vivax* is 22 days while for *P.falciparum* it is 35 days. Thus a surveillance cycle of less than one incubation interval will catch most of the secondary cases before the commencement of next cycle. Through this activity, the malaria prevalence can be measured. On the other hand in countries where the rural health services are still at an early stage of development, periodic malaria surveys should be carried out to supplement the data generated by the health services to estimate malaria endemicity of the area.** The results of these surveys would enable the health authorities to formulate malaria control policy.

After the slides are collected from the fever cases, they are examined microscopically for presence of malaria parasite and identification of the species. From the slide examination data, the parasitological parameters calculated are:

a. Slide Positivity Rate (SPR)

$$\frac{\text{No. of blood smears found positive for malaria parasite}}{\text{No. of blood smears examined}} \times 100$$

b. Slide *falciparum* Rate (SfR)

$$\frac{\text{No. of blood smears found positive for } \textit{P.falciparum}}{\text{No. of blood smears examined}} \times 100$$

c. *P.falciparum* Percentage (Pf%)

$$\frac{\text{No. of blood smears found positive for } \textit{P.falciparum}}{\text{No. of blood smears found positive for malaria parasite}} \times 100$$

d. Annual Parasite Incidence (API)

$$\frac{\text{No. of blood smears found positive for malaria parasite}}{\text{Total population under surveillance}} \times 1000$$

ii. Epidemiological Significance of Slide Positivity Rate (SPR)

Out of the large number of parameters calculated from the data collected through surveillance operations, the most important is the **slide positivity rate**. This rate gives indication about the monthly/yearly parasitic load in the population under surveillance. ***P.falciparum*** and ***P.vivax*** **percentage indicates the species distribution pattern of malaria parasite in the community. Under Indian conditions they vary from season to season and year to year.**

The parasite prevalence in the community and its species distribution give an estimate of the transmission level of malaria in an area during the epidemiological year or in any other time frame such as monthly intervals. When compared with the previous year's incidence, it would indicate whether malaria incidence in the community is increasing or decreasing due to effective control measures. **Monthly trends of malaria incidence are used to study the impact of control measures on local transmission. These monthly trends over three consecutive preceding months as well as the trend in the preceding three years give information about the build-up of parasite reservoir in the population. This information is used to draw epidemiological inference as regards to the possibility of an epidemic build up much before the event. It has been suggested that if the**

monthly incidence as reflected by MPI (Monthly Parasite Incidence) or SPR trends show an increase of 2½ times of the standard deviation of monthly averages it is suggestive of ineffectiveness of the control measures. In other words, the control operations have failed to interrupt transmission and possibly an epidemic condition is being generated in the area. A close monitoring of epidemiological picture is required to pre-empt a malaria epidemic in near future.

It is not desirable to discard the parasitological indices developed for measurement of malaria during eradication programme. They are still valid and give more accurate information on malaria endemicity than periodic malaria surveys. This statement will be valid provided the organisation existing under rural health services conducts fortnightly domiciliary visits. Adequate manpower under rural health services has an added advantage as this organisation can give prompt treatment to malaria cases, reducing the morbidity and mortality in the area.

In case the malaria incidence in an area cannot be controlled by the existing control measures and there is a focal outbreak, even then it is not warranted to disband the usual malaria surveillance operations. Mass blood smear collection should be carried out to assess the epidemiological status; endeavour should be made to revitalise the existing organisation under the rural health system and the required information should be generated through this organisation. This information will definitely be more accurate and reliable and will help in pinpointing the lacunae in the control operations. The prompt treatment to the malaria cases in the area at regular fortnightly interval should be ensured through the revamped surveillance organisation.

The above measures, if implemented in time, will help in reducing malaria morbidity. They will also help to prevent malaria mortality. While revamping rural health organisation, the lacunae identified in the implementation of intervention measures can be removed by suitable administrative follow-up action. This had been the experience of authors while dealing with frequent outbreaks of malaria in India in the course of implementation of Modified Plan of Operation in rural areas.

Many public health administrators and technocrats suggest malaria survey to reassess the malaria endemicity of the areas involved in focal outbreaks which may not be the correct approach for situation analysis or for taking decision to change control operations or strengthening of organisation as a remedial measure. As suggested earlier, revitalising the existing rural health organisation is a much better alternative and this organisation should be made to implement the control strategy as per plan and technical schedule. Probably this can be better achieved through a process of decentralised planning, where job responsibilities are vested with the middle level managers with greater accountability thus leading to proper monitoring and supervision.

iii. *P.falciparum* Percentage - its Significance

The gradual increase in *P.falciparum* percentage can be brought about by:-

a. Environmental changes through developmental activities. These changes some times may produce long-term adverse impact on epidemiological situation. If timely corrective modifications in the development project design are not carried out, the environmental degradation so produced may prolong the local transmission period resulting in a large number of *P.falciparum* cases occurring during the epidemiological year. On account of increase in *P.falciparum* incidence, there is a change in the species distribution pattern in the area.

b. Whenever the chemotherapeutic measures are not adequate or timely, radical treatment to *P.falciparum* cases in the community, is not given promptly to liquidate the circulating gametocytes it results in increased malaria transmission and a larger number of secondary *P.falciparum* cases occur. The above situation coupled with the failure of intervention measures to interrupt transmission further contributes to an increase in *P.falciparum* prevalence and rise in its percentage in the total malaria incidence.

c. When the intervention measures for transmission control are not effectively carried out and transmission continues more or less at the same level as in the pre-control era, *P.falciparum*

percentage would be similar to that observed before the control programme was implemented in the area. There will be very little change, if any, in the parasite formula of the locality because continued transmission would also produce equally large number of *P.vivax* cases thus keeping the balance in the ratio of *P.vivax* and *P.falciparum*.

d. In case the intervention measures are effectively carried out in the early part of the transmission period, these measures will cut off the peak of *P.vivax* transmission. If these intervention measures are not effective in cutting the peak of transmission during the later part of the transmission period, there will be an increase in *P.falciparum* incidence because of prolonged and intense transmission in the later months. Therefore, ratio of *P.vivax* and *P.falciparum* will change and the *P.falciparum* percentage will increase.

e. In some areas, in spite of reduction of total number of *P.falciparum* cases, *P.falciparum* percentage may show increase because effective intervention measures in the early period of transmission produce greater impact on *P.vivax* transmission.

iv. Effect of ABER on SPR and API

The quality and quantity of blood smear collection, its distribution in time and space produce marked variation in the ultimate malaria situation of the area. The API calculations are based on positives detected out of the slides collected by the surveillance organisation. If the ABER is low, and the blood smear collection during transmission period is also not adequate, the number of positives detected from surveillance will not give accurate information of malaria incidence in the area. On the other hand, if blood smears are collected from a large number of healthy persons in an attempt to fulfill the ABER targets, the high ABER figures will not materially affect the API, but the Slide Positivity Rate (SPR) will go down.

Therefore in areas with deficient ABER, SPR is a better indicator of malaria endemicity than API. On the other hand, with high ABER and indiscriminate collection of blood smears from afebrile cases in an attempt to meet or exceed the targets laid down, the SPR loses its epidemiological significance and API gives a better indication on parasite prevalence in the community.

In the course of the revitalisation of rural health organisation the lacunae identified in the implementation of intervention methods can be removed by suitable organisational and administrative follow-up actions. This has been the experience of the authors while dealing with frequent focal outbreaks of malaria in India during the implementation of Modified Plan of Operation in rural areas.

When marked variations are seen in the ABER, the local Epidemiologist should try to analyse the situation by applying a suitable corrective technique. The formula suggested below can be tested under the field conditions and if necessary suitably modified to meet the local requirements. This approach is adopted so that the corrected indices give more valid information on incidence of malaria in the community.

Correction Formula

If in an area the ABER is 6% or below due to poor surveillance or vacancy of MPW for prolonged period, an arbitrary correction method can be incorporated to overcome this lacuna. The method for correction is given below:-

In a population of 10,000 the blood smears collected were 600 and malaria positives were 18 during a year.

ABER - 6%

API - 1.8

SPR - 3%

Correction factor incorporating as if the ABER were 10% (i.e. the recommended norm of ABER under NMEP)

$$\text{Corrected API} = \frac{1.8 \text{ X } 10}{6} = 3$$

Thus the corrected API of 3 is 66.7% more than the actual API obtained with insufficient surveillance mechanism.

It will be observed that the corrected API of 3 as per the formula given above is exactly equal to the SPR of the area.

SUMMARY OF PARAMETERS USED TO MEASURE MALARIA ENDEMICITY

The epidemiological significance of different parasitological and other parameters and precautions to be observed while interpreting the data are summarised below:-

i. Spleen Rates

Precautions

a. Spleen palpation is a specialised technique and should be carried out carefully by an experienced worker.

b. Sample size should be statistically valid.

c. Both sexes should be proportionately represented.

d. Spleen examination should be carried out in all age groups, but child spleen rates are used to measure malaria endemicity levels in the area.

e. The spleen survey can be carried out at any time but results of post transmission survey are more informative.

f. The spleen enlargement is graded according to Hackett's method.

g. Average Enlarged Spleen (AES) index is used to interpret recent and past epidemiological events.

h. Splenic enlargement can be due to other tropical diseases and disease syndromes prevalent in the area.

i. Splenic enlargement does not indicate quality or quantity of malaria immunity in the patient.

Interpretation

a. Spleen enlargement indicates community/ individual's experience with malaria in the past.

b. Child spleen rate in age group of 2-9 years is used to classify an area on endemicity scale.

c. An average enlarged spleen of 'one' (1) indicates recent exposure to malaria during a focal outbreak. The population was exposed to malaria transmission for more than 2 to 3 weeks.

d. In those malaria cases whose parasitaemia is terminated within 1-2 weeks of primary bout, no splenic enlargement is detected.

e. AES of 1.5 or above shows repeated exposure to malaria infection over a long period of time.

f. An AES of 3 and above is seen in hyper and holoendemic areas without facilities for malaria chemotherapy. In these areas individuals are exposed to continuous parasitaemia over a much longer period.

g. If there is no further exposure to malaria, Class 1 and 2 spleen regresses to normal size in 12 to 24 weeks. Class 3 or bigger splenic enlargement takes longer period to regress. Therefore, it can be used to interpret the impact of control measures on local transmission of the area.

h. When early case detection and prompt treatment are in full operation, the spleen rates do not indicate the endemicity in the area since enlarged spleen is seldom encountered in such a situation.

i. The spleen rates do not give any indication about the prevalence of parasitic species in the area and also the levels of parasitaemia in the individual/community.

j. The spleen is not palpated in children below two years because the spleen normally does not recede below the costal margin before this age.

k. Size of splenic enlargement in children after the age of 8 to 10 years is affected by development of immunity which reduces parasite density in the peripheral blood and in holoendemic areas adults do not show splenic enlargement.

Spleen Rate and Average Enlarged Spleen index are useful parameters. All things being equal, the high Spleen Rate with low Average Enlarged Spleen index indicates that treatment to malaria cases is delayed and probably it is inadequate.

ii. Child Parasite Rate (CPR)

Precautions

a. Sample size should be statistically valid.

b. Both sexes should be proportionately represented.

c. All children irrespective of their fever status should be included in the sample.

d. The age composition of the sample should be between 2 and 9 years as in the case of spleen survey.

Interpretation

a. Child Parasite Rates give the distribution of malaria parasite species in the local population at a point of time.

b. This is used to compute parasite formula for the area i.e. the relative proportion of *P.vivax, P.falciparum* and *P.malariae* in the area.

c. It reveals which of the parasite species is predominant in the area.

d. It is utilised to grade the area on endemicity scale.

e. If younger age group is found negative, but older age group shows malaria infection, it may be inferred that in the recent past, the malaria transmission in the locality has been interrupted.

iii. Infant Parasite Rate (IPR)

Precautions

a. The infants of both sexes are included in the sample.

b. A child who has not completed 365 days after birth is taken as an infant.

c. In longitudinal studies, each infant born in the locality is included in the sample at the time of birth.

Interpretation

a. It confirms the local transmission of malaria during the current transmission period.

b. In the cohort studies when the first infant is reported positive, calculation regarding commencement for transmission period is based on this date.

c. High infant parasite rates indicate the high endemicity and malaria transmission during the current epidemiological year.

d. Infant Parasite Rates along with Child Parasite Rates have been used to measure the malaria endemicity of an area.

The cohort studies on infant parasite rate are usually not necessary in countries where the transmission period has been ascertained in the past and there are no local socio-economic/ ecological changes indicating change in transmission period. Such studies are essential for unmapped areas where it is proposed to start malaria control operations.

iv. ABER

a. ABER should be equal to fever rate in the community.

b. It should be well distributed over different months of the year.

c. Slide collection should be higher during the transmission period as compared to the non-transmission period.

d. All age groups as well as both sexes should be represented.

e. The slides collected should also include infant slides from the area, because if there is local transmission in the area some of them may be positive.

f. All sections of the community and each village should be under surveillance at fortnightly interval.

g. ABER cannot be made up by ad-hoc mass blood smear collection at irregular intervals or by including the slides collected during the malaria survey carried out in the areas. All such procedures will give wrong epidemiological information.

v. Slide Positivity Rate (SPR)

a. The Slide Positivity Rate among the blood smears collected through both active and passive surveillance gives a more accurate information on distribution of malaria infection in the community over a period of time.

b. Monthly SPR can be calculated to find out the seasonal rise and fall in malaria prevalence in the community.

c. SPR among children 2-9 years of age can be utilised for comparison with pre-control Child Parasite Rates to assess the impact of control measures on local malaria endemicity and transmission.

d. SPR in the age group of less than one year (Infant Parasite Rate) can be utilised for assessment of the impact of control operations.

e. The SPR of blood slides collected from cases currently having fever will be higher than the SPR of the slides collected from cases with history of fever. Therefore, higher positivity rates are obtained in blood smears collected at the PCD.

f. Trends in SPR can be utilised for predicting epidemic situations in the area. If monthly SPR exceeds by 2½ times of the standard deviation observed in SPR of the preceding 3 years or preceding 3 months of the same year, an epidemic build up in the area can be suspected.

g. Monthly or yearly trends of SPR are utilised to study the impact of control operations.

vi. API

a. API can be utilised for assessing the malaria endemicity in the area and impact of control operations provided the ABER is equivalent to fever rate in the community.

b. During malaria eradication operations API was used as an epidemiological parameter for entry of areas in advance phases (i.e. from Attack to Consolidation or from Consolidation to Maintenance) of the programme.

c. In 1968 API was used as a basis for reversion of maintenance and consolidation phase areas to attack phase. Later on in 1977 it was used for planning of selective insecticidal spray operations under the Modified Plan of Operation.

d. Similar interpretation as in case of SPR can be made by study of API.

vii. Malaria Measurement through Clinical Diagnosis

The malaria incidence of a locality can also be measured on the basis of the clinical diagnosis. Every medical institution is expected to keep records of the number of fever cases attending the OPD. The fever cases are further categorised on the basis of clinical diagnosis, malaria being one of them. The hospital data, if properly analysed, give information regarding malaria incidence in the area catered to by the concerned medical facility.

viii. Proportional Case Rate (PCR)

The evaluation of the impact of National Malaria Control Programme was carried out by studying the **Proportional Case Rate of Malaria** . The proportional case rate was arrived at by finding out the **ratio of clinically diagnosed malaria cases to the total fever cases attending the medical institution**. When National Malaria Eradication Programme was launched, the above practice was discontinued. The impact of eradication measures was evaluated by calculating API and SPR from the data collected through surveillance organisation. The API and SPR gave more accurate information on malaria incidence as they were based on microscopic confirmation of malaria diagnosis of fever cases. At present in the reporting system under the General Health Services, report on number of fever cases *vis-a-vis* clinically diagnosed malaria cases is not collected. Therefore, it is not possible to measure malaria morbidity of an area based on clinical diagnosis. A system of reporting of fever cases and clinically diagnosed malaria cases is likely to be introduced soon in the programme. When the field data are available, the Proportional Case Rate can be calculated and compared yearwise or monthwise as required for epidemiological assessment of malaria incidence in the area. This will be an additional tool for measuring malaria morbidity.

Some studies were carried out by Malaria Research Centre to assess accuracy of clinical diagnosis of malaria. It was observed that chances of clinically diagnosed malaria being positive for malaria parasite were 50:50. Similarly those fever cases which were not clinically diagnosed as malaria cases but after their blood smears were examined some of them were found positive for malaria parasite. The above observation reveals that clinical diagnosis even by a trained medical practitioner, under OPD conditions is not likely to be an accurate tool for assessment of malaria incidence in an area. Similar studies in other malarious areas of the world reveal that clinical diagnosis of malaria is not a very accurate tool for measuring malaria morbidity. This aspect is dealt in detail in Chapter-4 on Clinical Malaria.

The implementation of the scheme on reporting of fever incidence and clinically diagnosed malaria cases is likely to take some time. Till then an alternative method for more accurate estimation of fever and malaria incidence in the community can be adopted within the Primary Health Care System. This will require total coverage of population for fever survey and examination of slides from fever cases/cases with history of fever from one subcentre per district or group of districts falling in the same malaria paradigm. A model protocol is given in Annexure - 2.1.

MEASUREMENT OF MALARIA MORTALITY

The NMEP was launched in 1958 and by 1965, the incidence of malaria was reduced to a very low level. No mortality due to malaria was reported for over next 16 years. Stray reports of deaths due to malaria were recorded in the year 1975 and since then the deaths are being reported regularly by the malaria organisation of many States. Once it was accepted that mortality due to malaria can occur in spite of implementation of malaria control activities, regular statistics on malaria mortality were kept by Directorate of NMEP. It was observed that the physicians especially at district hospitals and medical colleges had a tendency to report malaria deaths indiscriminately on clinical diagnosis alone without the supporting microscopic evidence. It is a well known fact that direct mortality due to malaria can occur in a serious and complicated *P.falciparum* case alone and not in patients with *P.vivax* and *P.malariae* infections. Some studies have shown that in remote holo/hyper endemic areas nearly 2% of total, *P.falciparum* cases in non-immune persons are likely to develop serious complications of malaria. In view of the availability of Chloroquine all over India including remote areas through the programme or market sources and semi-immune status of the population, the figures of complicated and serious malaria cases may be lower. It can therefore be presumed that 0.5% of total *P.falciparum* cases in a community may develop serious complications of malaria. Cerebral malaria is the more frequent of the serious complications of malaria. The mortality in cerebral malaria cases is approximately 20%. In view of the above, the Directorate of NMEP decided that any report of death due to malaria should be supported by microscopically confirmed *P.falciparum* infection. In pursuance of these guidelines number of deaths were regularly reported by the District Officials. Table-2.1 gives Statewise mortality due to *P.falciparum* malaria from 1974 to 1995.

The percentage distribution of malaria deaths to total deaths and fever deaths reported by the Registrar General of India for 21 States and UTs against the incidence of *P.falciparum* cases and deaths recorded by NMEP pertaining to 1992 are given in Table-2.2.

Many health administrators and technocrats are of the opinion that there is a gross under-reporting of malaria deaths in the country. It is true that in such a gigantic programme, there is likely to be some under-reporting of malaria mortality. However, it is a fact that direct mortality due to malaria infection occurs in *P.falciparum* cases only because of specific pathological process of cyto-sequestration and cyto-adherence of infected RBCs. In *P.vivax* and *P.malariae* infection, direct mortality due to parasite infection is not encountered.

The complications on account of *P.falciparum* infection occur in all age groups but encountered

Table-2.1: Statewise Mortality due to Malaria Recorded by NMEP (1974-1995)

S. No.	Name of the State/UT/Others	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995(P)
1.	Andhra Pd	-	-	1	-	-	-	-	-	-	-	-	-	1	1	1	2	5	2	-	7	9	4
2.	Assam	-	68	44	35	30	58	47	49	27	16	20	23	39	14	4	6	16	36	20	48	69	300
3.	Bihar	-	2	2	-	-	5	4	5	7	6	11	19	19	11	4	13	107	14	21	2	12	21
4.	Gujarat	-	-	-	-	-	-	-	-	-	-	-	-	-	4	67	60	84	37	28	25	14	5
5.	Haryana	-	-	-	2	1	1	1	-	1	2	2	-	-	-	-	-	-	-	1	-	-	-
6.	Himachal Pd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	J & K	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	Karnataka	-	1	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	8	-	-	3	20
9.	Kerala	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	-	2	-	1	2
10.	Madhaya Pd	-	-	-	-	1	2	25	16	28	13	12	3	10	13	8	16	3	28	39	12	28	19
11.	Maharashtra	-	1	1	-	1	-	5	-	5	1	-	2	6	2	5	8	6	15	2	15	9	219
12.	Manipur	-	-	-	-	4	-	3	2	5	1	-	1	4	-	2	2	-	-	9	9	55	17
13.	Meghalaya	-	-	-	-	-	8	12	1	5	1	-	-	1	1	-	-	-	-	-	-	11	18
14.	Nagaland	-	3	-	-	-	17	4	2	-	-	-	-	1	-	-	-	-	-	-	-	253	-
15.	Orissa	-	1	-	-	-	41	42	51	43	50	49	67	155	90	82	118	147	233	155	118	78	163
16.	Punjab	-	-	1	-	-	-	-	-	-	41	58	29	11	-	-	2	-	-	-	-	1	8
17.	Rajasthan	-	-	-	-	-	-	-	-	1	-	-	4	2	-	2	1	65	10	55	19	452	45
18.	Sikkim	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
19.	Tamil Nadu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	9	7	1
20.	Tripura	-	-	-	5	27	27	5	13	17	13	24	8	11	5	1	5	4	7	6	19	20	12
21.	Uttar Pradesh	-	-	1	1	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-
22.	West Bengal	-	4	2	1	1	1	3	4	21	4	6	14	20	17	5	16	4	13	43	37	52	107
23.	A & N Islands	-	-	-	1	-	-	30	4	1	2	1	-	-	1	1	1	-	2	1	1	1	2
24.	Arunachal Pd	-	4	-	9	9	14	17	6	4	1	-	1	1	-	2	-	1	-	-	-	6	-
25.	Chandigarh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26.	D & N Haveli	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27.	Delhi	-	-	-	-	-	-	-	-	-	52	40	27	-	-	-	-	-	-	1	-	-	-
28.	Goa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
29.	Lakshadweep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30.	Mizoram	-	15	1	1	-	3	-	4	8	5	6	5	34	28	16	17	8	12	36	33	41	49
31.	Pondicherry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32.	Coalfields	-	-	5	-	-	1	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
33.	DNK Project	3	-	1	-	-	20	8	12	14	15	18	8	5	-	-	-	-	-	-	-	-	-
	INDIA	**3**	**99**	**59**	**55**	**74**	**198**	**207**	**170**	**187**	**239**	**247**	**212**	**321**	**188**	**209**	**268**	**453**	**421**	**422**	**364**	**1122**	**1012**

Table- 2.2: Percentage Distribution of Malaria Deaths to Total Deaths and Fever Deaths in India Reported as per Registrar General of India (RGI) as Against Incidence of *P.falciparum* Cases and Deaths as Recorded by the National Malaria Eradication Programme for the Year: 1992.

S. No.	Name of the State/ UT	RGI Data			NMEP Data			Comparison of Mortality due to malaria		
		Malaria Deaths	Fever Deaths	Malaria Deaths	No. of *P.falciparum* cases	*Pf%*	ABER	RGI estimates	Estimates	Actual deaths as per NMEP
		As % of total deaths	As % of total deaths	As % of fever deaths						
1	2	3	4	5	6	7	8	9	10	11
1.	Andhra Pd	0.1	1.3	7.7	26,594	33.1	13.0	441	27 (108)	0
2.	Assam	0.0	4.0	0.0	62,118	65.3	9.8	0	62 (248)	20
3.	Bihar	1.4	10.0	14.0	43,191	66.1	1.7	6,536	43 (172)	21
4.	Goa	0.0	2.1	0.0	202	23.8	6.7	0	0 (0)	0
5.	Gujarat	0.8	6.3	12.7	98,213	28.2	17.1	1,836	98 (392)	28
6.	Haryana	0.2	13.8	1.4	1,238	7.4	11.5	256	1 (4)	1
7.	Himachal Pd.	0.3	2.9	10.3	9	0.1	17.1	104	0 (0)	0
8.	Karnataka	0.1	1.9	5.3	16,578	20.5	17.8	291	17 (68)	0
9.	Kerala	0.0	1.1	0.0	224	2.7	4.6	0	0 (0)	2
10.	Madhya Pd.	7.0	16.6	42.2	1,53,499	56.9	10.6	28,837	153 (612)	39
11.	Maharashtra	0.0	1.8	0.0	61,104	30.0	12.7	0	61 (244)	2
12.	Manipur	0.0	8.9	0.0	916	43.2	10.4	0	1 (4)	9
13.	Meghalaya	0.0	13.7	0.0	6,863	60.8	11.4	0	7 (28)	0
14.	Orissa	0.6	4.4	13.6	3,07,056	84.7	11.9	1850	307 (1228)	155
15.	Punjab	1.4	24.0	5.8	184	0.8	12.0	1789	0 (0)	0
16.	Rajasthan	0.8	12.9	6.2	41,513	34.2	8.7	2831	42 (168)	55
17.	Tamil Nadu	0.1	5.1	2.0	12,112	8.0	10.6	390	12 (48)	2
18.	Tripura	0.0	24.5	0.0	6,970	74.6	6.4	0	7 (28)	6
19.	Uttar Pradesh	1.2	9.0	13.3	12,324	9.1	7.6	16,517	12 (48)	0
20.	D & N Haveli	0.0	9.5	0.0	787	11.8	32.2	0	1 (4)	0
21.	Delhi	0.0	6.3	0.0	90	0.8	12.2	0	0 (0)	1
	Total	**1.0**	**7.7**	**13.0**	**8,51,785**	**41.3**	**9.6**	**61,678**	**852 (3408)**	**341**

N.B.: Figures in parasentheses in col. 10 give the upper most limit of estimates

more often in children. Some of the malaria deaths in children go unreported especially from tribal and hilly areas. Therefore, the mortality estimates due to *P.falciparum* infection are quite low. Further the hospitals and other medical institutions do not feel obliged to send mortality reports on malaria to the District Malaria Officer, State Health Directorate or even to the Dte. of NMEP as reporting of malaria death is not obligatory. Even in hospital conditions, most of the malaria deaths are based on clinical diagnosis by the physician, usually without parasitological confirmation. **In view of this, as stated earlier, Directorate of NMEP insists that only those reports should be taken cognizance of where parasitological confirmation of *P.falciparum* has been made.**

On the other hand some Health Authorities compute malaria deaths on the basis of the findings of vital statistics survey carried out by the Registrar General of India, Ministry of Home Affairs. They estimate that malaria mortality in the country lies between 50,000 and 1,00,000 per year. A careful analysis is required to authenticate these estimates.

The Registrar General of India, Ministry of Home Affairs is entrusted with collection of data on vital statistics in the country. Out of the total Block level PHCs, they have selected 1305 PHCs. The number of PHCs selected from a State is decided on the proportionate population of the State to total population of the country. Normally the PHC Headquarters village is selected as a sentinel centre. Only under rare circumstances, a village within 3 to 5 kms. of PHC Headquarters has been taken as the sentinel centre. **The technique adopted by the vital statistical survey is 'lay diagnosis reporting'. The paramedical staff is deployed to collect the information from local residents like Dai (traditional birth attendant), Nai (barber), Chowkidar (village guard) , Social Worker, village headman, etc.** Along with the report on the vital incidence, these people also give the cause of death as perceived by them based on 'lay diagnosis'.

During 1992, a total number of 1203 out of 1305 PHCs functioning as sentinel centres of the survey submitted complete reports from 21 States/Union Territories covering a population of 34,72,179. The number of total deaths reported in the above population were 2,26,118. Malaria deaths contributed 1% of the total deaths.

In Table-2.2, Statewise percentage of malaria deaths as compared to total deaths and fever deaths is given in column 3 to 5. The extrapolation of malaria death rates recorded in the sample population to the total population of each State/ U.T. is given in column 9. The column 6 gives the total number of *P.falciparum* cases recorded by the NMEP organisation in the State. *P.falciparum* percentage out of the total malaria cases is given in column 7. It will be observed from column 8 that the average ABER of the States for 1992 is nearly 10% or above which is considered adequate. column 9 indicates the total malaria deaths computed for each State by applying the malaria mortality rates collected by the Registrar General of India to the total population of the State. The next column 10 gives the estimated deaths on the basis of the observations that only 0.5% of *P.falciparum* cases go into serious complication(s) and 20% of them die in spite of best treatment. In parentheses the figures @ 2% level are given thereby showing the range of maximum and minimum deaths within which the actual number of deaths may lie. These figures are calculated on the basis of total number of *P.falciparum* cases recorded by the State (column 6). The last column indicates the actual deaths reported to NMEP, which were found positive for *P.falciparum* infection on microscopic examination.

While analysing the data presented in Table - 2.2, the following facts should be observed.

a. Only in *P.falciparum* cases, direct mortality due to malaria infection occurs.

b. The distribution of mortality will be much higher in hilly and foothill areas where *P.falciparum* is a predominant infection.

c. Malaria mortality is very high in infants and young children and there is gross under-reporting of the data.

The mortality as reported by the Registrar General of India and recorded by NMEP are compared in the following four sets of situations.

i. States Recording High *P.falciparum* Incidence

The State of Madhya Pradesh has recorded 1.53 Lakh cases of *P.falciparum* and the State of Orissa has recorded 3.07 Lakh *P.falciparum* cases. The mortality estimates on the basis of Registrar General's observation come to 28,837 and 1,850 respectively for the above States. This does not reflect the true picture because Orissa having recorded higher number of *P.falciparum* cases should have recorded much higher mortality due to malaria. The mortality recorded in Madhya Pradesh is 15.5 times more than Orissa but actual *P.falciparum* incidence is lower than Orissa. The situation is anomalous. Looking through another angle, of the total 61,678 deaths estimated by Registrar General of India, Madhya Pradesh contributed 46.7% of total deaths whereas the *P.falciparum* cases were only 18% of the total malaria cases in the country. In case of Orissa 3.0% of deaths were recorded when it had contributed 36% of the total *P.falciparum* cases. The topography, terrain and health facilities are more or less of the same standard in the tribal areas of Orissa and Madhya Pradesh. Therefore such a wide fluctuation in malaria mortality is not rational.

ii. States showing Low *P. falciparum* Incidence

The two States of Punjab and Haryana have recorded very low number of *P.falciparum* cases - 184 and 1238 respectively. The surveillance system in both these States is satisfactory. Health Organisation is much better as compared to many parts of the country. The reporting of *P.falciparum* incidence is more or less accurate. On the basis of malaria mortality figure of Registrar General of India, Punjab showed 1,789 malaria deaths while in case of Haryana 256 malaria deaths were reported. The mortality due to malaria in Punjab is nearly 9.7 times more than the total number of *P.falciparum* cases reported in that State. According to the reports received at Dte. of NMEP and the estimates based on observed *P.falciparum* mortality, there should be no death due to malaria in Punjab and only 1 death in case of Haryana.

iii. States with High *P. falciparum* Percentage

According to the Registrar General of India, there is no mortality due to malaria in Assam, Meghalaya, Manipur, Tripura and Maharashtra, although these States have recorded sizeable number of *P.falciparum* cases and the percentage of *P.falciparum* varies from 40% to 74%. Therefore there should have been mortality due to *P.falciparum* in these States. On the basis of observed mortality patterns in *P.falciparum* the mortality figures for these States are given in column 10. From these States NMEP has received reports of mortality of duly confirmed *P.falciparum* cases. State of Assam has reported 20, Manipur 9, Tripura 6 and Maharashtra 2 deaths.

iv. States with Large Population and Variable *P. falciparum* Percentage

In the last category, Uttar Pradesh, Andhra Pradesh and Bihar States should show very high malaria mortality of 16,517, 441 and 6,536 respectively based on Registrar General's vital statistics estimates. Here it may be mentioned that in these States only a few districts report *P.falciparum* cases. These districts have some hilly and tribal pockets. A very large population resides in plain areas where *P.vivax* is the predominant infection. Therefore, there could not be such high mortality due to *P.falciparum* in these States. Moreover, *P.falciparum* percentage in the State of Uttar Pradesh is very low (only 9.1%). But in case of Bihar and Andhra Pradesh it is 66.1% and 33.1% respectively which is mostly localised to tribal areas. The deaths reported by the State of Bihar were 21 for the year 1992 as recorded by Directorate of NMEP. The death reports for Uttar Pradesh and Andhra Pradesh were nil.

In conclusion, **it is accepted that there is under-reporting of malaria deaths by the peripheral staff to the Dte. of NMEP. The true death rate may lie somewhere in between the figures given in column 10 i.e. estimates of deaths on the basis of observed mortality in *P.falciparum* and not on the 'lay diagnosis' basis as recorded by Registrar General of India.** Therefore, the total mortality due to malaria in these 21 States and Union Territories should lie anywhere between 850 and 3,500.

Over-Reporting of Malaria Deaths during Epidemic

During an epidemic, when a large number of *P.falciparum* cases are confirmed microscopically and both SPR and SfR are high, large number of deaths are attributed to malaria only on clinical diagnosis without supporting evidence of microscopic confirmation. The malariologists and local public health officers are not in a position to deny/disown such deaths because of high prevalence of *P. falciparum* in the community. Therefore, a treating physician who reports such deaths should be cautious in labelling fever deaths as deaths due to malaria if the blood smear has been collected from a fever case and found negative, even though the sign & symptoms in the patient resembled those seen in cerebral malaria.

The cause of deaths in microscopically negative cases should not be attributed to malaria

The treating physician should exhaust all avenues of differential diagnosis including parasitological, bacteriological, biochemical and other serological tests before labelling such a case as a case of malaria. However, this dictum should not be followed while treating such a case and only on clinical suspicion antimalarial should be given along with supportive therapy.

It is, therefore, incumbent on the programme officers entrusted with malaria control operations to convince the treating physicians to be careful in classification of fever deaths and consider only those who are found positive for *P. falciparum* alone. If necessary, patient's blood smear should be repeatedly examined at 6 hourly interval till diagnosis of *P.falciparum* is confirmed.

The clinical manifestations in *P.vivax* and *P.malariae* are comparatively mild and parasitic infection with these species does not cause fatal pathological changes in human beings except anaemia, splenomegaly and hepatic enlargement in long standing cases.

Therefore as a rule deaths in cases found positive for *P.vivax* or *P.malariae* infections should not be attributed to malaria and should not be categorised as malaria deaths.

It is evident that the mortality figures *per-se* do not form a good index for measurement of malaria prevalence in the community. Mortality is usually confined to highly malarious areas or during epidemic in other areas where *P. falciparum* infections predominate. The programme mortality figures do point out the fact that there are serious lacunae in implementation of control measures in the area and a thorough review of the situation is required if the control operations are expected to achieve the objectives laid down.

The malaria mortality, therefore, points at:

i. Serious lacunae in the implementation of the ongoing programme

ii. Presence of *P. falciparum* infection in the community

iii. Possible existence of resistant foci of *P. falciparum* in the area

iv. A breakdown in early case detection and treatment of malaria cases through surveillance operations

v. Inadequate arrangements for treatment of serious cases of malaria

vi. Existence of a focal epidemic in an area which requires immediate attention for implementing a crash programme to liquidate the infection from the community.

vii. It will not be realistic to estimate the number of malaria cases on the basis of Chloroquine production or consumption in the country. Chloroquine is extensively used for treatment of other ailments, one of the major ailments being amoebiasis especially amoebic hepatitis. Amoebiasis is endemic in India. Every year a large number of amoebic hepatitis cases occur in the country. It is presumed that a sizeable quantity of Chloroquine tablets is used for treatment of amoebiasis. There are several other diseases where Chloroquine is utilised by the private practitioners. Therefore, in this book, no

attempt is being made either to quantify the malaria incidence or mortality on the basis of drug consumption in the country.

OTHER EPIDEMIOLOGICAL PARAMETERS

Other observations which can be used for epidemiological assessment of malaria situation are:-

a. Ratio of High Vs Low *P. falciparum* Densities in Peripheral Blood

If the malaria control organisation has the facility to do parasite count of all blood smears or even selected blood smears collected at the periphery and it can analyse the data, the increase in the ratio of *P.falciparum* densities to those showing low *P.falciparum* parasite densities in peripheral blood will indicate that fresh transmission in the community has started and it can also be used as a parameter for assessing the impact of control operations. Lesser is the proportion of high density cases in an area better is the impact of control operation.

b. A study of Slide Positivity Rate and Slide *falciparum* Rate by age group is one of the tools to show which age group is more vulnerable to malaria infection in the local malaria paradigm. Depending on the socio-economic activity of the people and their cultural beliefs, different sections of the population have variable opportunity of exposure to malaria. Thus, same age groups in some areas are more vulnerable whereas they may not be having similar malaria risk in a different situation. The District Malaria Officer or State Malariologist should study the SPR/SfR by age group and further critically analyse it monthwise. This exercise will give better insight on the malaria endemicity in the area.

c. The ratio of *P.falciparum* - ring and gametocytes (PfRG) to total *P.falciparum* cases will give an indication how early is the case detection and prompt treatment mechanism in the area. If cases with *P.falciparum* G/RG are proportionately higher than cases with *P.falciparum* ring only, it indicates that the case detection and treatment are delayed because in *P.falciparum* infections the gametocytes appear much later i.e. 7 to 10 days after the onset of fever episode.

d. Clinically Suspected Malaria Cases to Total Attendance

The topic is discussed in detail under clinical diagnosis of malaria. However, a malariologist must keep in mind that clinically suspected malaria cases to total attendance at an Institute varies from place to place and from time to time depending on the catchment area of the passive agency and proficiency or attitude of the physician in suspecting or diagnosing malaria cases. If the clinical diagnosis is being practised regularly, the proportional case rate can be taken as one of the parameters for assessment of malaria in the area. The proportional case rate indicates the proportion of clinical malaria cases to total out-patient attendance in a hospital. A similar calculation can be done for in-patient cases.

e. There are several other indicators like malaria in-patient admissions to total admissions in the hospital or malaria in-patient admissions in relation to population of the area. Serious complications of malaria occur only in *P.falciparum* cases. Therefore, the analysis of this type of data will give indication about (1) presence of *P.falciparum* infection in the community (2) development of complications in *P.falciparum* infection in the locality (3) delay or promptness of the referral system for treatment of malaria cases. Another possibility of detecting malaria infection in an in-patient is during routine blood examination. If this statistics is kept separately, it may give indication of malaria infection in the community especially among patients suffering from various diseases. Further, due to paucity of trained epidemiological component at the district or PHC level, such calculations are not done under the Indian Programme. Unless or until suitable augmentation is carried out and a trained epidemiologist is placed at district level with supporting staff, it will not be possible to pursue with this analysis. Moreover all medical institutions should report this statistics to the incharge of district malaria control operation who can utilise it for assessment of malaria morbidity in his area.

Annexure-2.1

MODEL PROTOCOL SUGGESTED FOR ESTIMATION OF TRUE FEVER RATE AND MALARIA MORBIDITY

Introduction

Many experts in public health have expressed doubt on the validity of malaria incidence reported by NMEP. The NMEP has prescribed ABER at 10 per cent presuming that the average fever rate in the community will be nearly 10 per cent. However, there are areas from where high ABER is recorded and in some areas which are traditionally malaria free, the ABER is as low as 1 to 2 per cent. To verify the validity of the NMEP data, a pilot study can be carried out in different parts of the country to ascertain true fever incidence rate and malaria incidence in different endemic zones for which a protocol can be prepared on the lines suggested below by the State Government or any other organisation taking up studies on this subject.

Objectives

- To ascertain the true fever incidence in a locality over a period of one year.

- To ascertain the malaria positivity in the fever cases or cases with history of fever over a period of one year.

- To study the parasite preponderance in different endemic zones of malaria.

- To compare the study data on the malaria positivity with NMEP records.

- To ascertain statistically the degree of difference, if any, between NMEP and study observation.

Methodology

A. Selection of Sample Size: Presuming that the fever in the community is 15% or more, statistically valid sample for a given population works out to approximately 3000 persons. This would give fever and malaria incidence values on 95 per cent confidence level with ± 10 per cent variation.

B. Selection of Study Area: Under the Primary Health Care System, there is a provision of one subcentre for 3,000 population in difficult terrain areas and 5,000 population in plain areas. In view of the sample size suggested above, the information on fever incidence in the community can be collected from one subcentre. If appropriately covered during study period, this population will provide accurate estimate of annual fever incidence and incidence of malaria (microscopically confirmed) in the locality.

a. The endemicity of malaria varies from place to place. However, broadly, it can be classified on the basis of child parasite rates or SPR into different categories. Therefore a two tier stratification technique is proposed. The total districts in the State can be listed on the basis of 5 year average ABER and they can be stratified into 5 categories.

i. Districts recording ABER less than 5%.

ii. Districts with ABER 5 to 7.5%.

iii. Districts with ABER above 7.5 to 12.5%.

iv. Districts with ABER above 12.5 to 15%.

v Districts with ABER above 15%.

Out of each category of districts as indicated above, one district should be selected by random number technique for the proposed studies.

b. In the selected district, all subcentres should be listed and they should be stratified according to class intervals suggested below:-

i. Subcentres with less than 2% SPR.

ii. Subcentres with 2 to 5% SPR.

iii. Subcentres with above 5 to 10% SPR.

iv. Subcentres with above 10 to 15% SPR.

v. Subcentres with SPR above 15%.

Classify them into 5 categories.

If a more precise information is required, then the class intervals for classification of subcentres can be less than 2% SPR, 2 to 5% SPR and thereafter each category having a difference of 2.5% SPR.

c. The subcentres are listed in different categories on the basis of SPR. In each category, the serial number should start with 1.

Thereafter a random number is selected for each category of subcentre and on the basis of this, one subcentre from each category is included in the study area. The districts and subcentres once selected randomly for inclusion should not be changed. No substitution should be permitted for collection of study data.

d. From each subcentre, the fever cases and cases with history of fever in between fortnightly domiciliary visits are searched and recorded.

e. From each fever case or case with history of fever, a blood slide will be collected for confirmation of malaria parasite. The persons from whom the slides are collected will be given a standard treatment with antimalarials as prescribed by NMEP.

Manpower

A worker will be required to cover subcentre on a fortnightly basis. He will carry out the domiciliary visit to each house in the subcentre and collect the information on fever incidence in the manner stated above. In case of vacancy of MPW in the selected subcentre, the State/District authority may opt for posting a good dedicated MPW to this area or select a temporary worker, post him after 7 days of training in malaria surveillance, slide preparation and administration of antimalarials. There may be occasions where the existing MPW of the subcentre selected is an indifferent and inefficient worker. In such a case the State Government will transfer him from the subcentre and in his place the arrangements as suggested above can be made.

a. During the house visit in the first fortnight, the worker will update the population census of the areas in MF-1.

b. He will contact each family during his house visit and obtain the fever history of each individual of the family and keep record in MF-1. Against individual's name in MF-1, he will give a suitable notation indicating his fever status- 'F' for a case having fever or giving history of fever in between the visits, 'NIL' for those members of the family who did not have fever during the fortnight.

c. He will collect blood smear from the fever case.

d. He will make the blood smear from the person giving history of fever over the preceding fortnight.

e. In case of the person giving fever history but not having fever at the time of visit, no special indication is required in MF-2.

f. In case the person with fever or history of fever during the previous fortnight is not present at his residence, the worker should try to locate the person in the village or contact him at a suitable time within 24 hours so that a blood smear can be collected.

g. In case it is not possible to collect the blood smear from a person having a fever episode within the fortnight, he will give suitable notation in MF-1 against the name of the individual with 'F' even though a blood smear is not collected from him.

Summary of Records

Each fortnight he will, in his register, maintain a summary record of fever cases as well as number of blood smears collected from fever cases for which the following format is suggested.

1. Number of total fever cases during the fortnight.

2. Number of total cases with fever history during the fortnight.

3. Total cases (1 + 2)

4. No. of total blood smears collected

5. Total positives a). *P.falciparum* cases and b). *P.vivax* cases

The fever cases and cases with fever history

are separately listed because occasionally the worker may not be able to contact a case giving history of fever prior to his visit and thus his name may not figure in blood smear collection.

Frequency of Data Collection

This routine should be carried out every fortnight through domiciliary visit for a period of one year.

Tabulation and Analysis

a. At the end of the year, the number of fever cases recorded from each subcentre are tabulated under each category to which it belongs (on the basis of original categorisation on API criteria).

b. Later on, annual fever incidence and SPR are calculated for each of the selected subcentres.

c. Having computed the SPR and fever rate of the each subcentre area, the Malaria Officer can apply these fever rates for total population of each category and record separately and thereafter compute average fever rate in the district.

d. The fever rate and positivity rate for the year under study should be compared with 5 yearly average positivity rate and ABER of each category of area to find out the difference between the routine NMEP data and the estimated fever rate and SPR for each district.

List of Subcentres - Average API of Five Years

Less than 2 - 5 S. No. Name	> 5 - 7.5 S.No. Name	>7.5 - 10 S.No. Name	>10 - 12.5 S.No. Name	Above 12.5 S.No. Name
1.				
2.				
3.				
4.				
Total				

SELECTED REFERENCES

1. Bruce-Chwatt, L.Jan (1985): Essential Malariology. Published by William Heinemann Medical Books Ltd. 23, Bedford Square, London WC **1B** 3HH.

2. Dte. of NMEP (1986): Malaria and Its Control in India Volume-**I** and **II.** Published by Dte. of NMEP, 22, Sham Nath Marg, Delhi-110 054.

3. Macdonald, G. (1957): The Epidemiology and Control of Malaria. Published by Oxford University Press. Amen House, London E.C.4.

4. Wernsdorfer, W.H. and Sir McGregor, I (1988): Malaria: Principles and Practice of Malariology Volume **I** and **II**. Published by Churchill Livingstone, Robert Stevenson House, 1-3 Baxter's Place, Leith Walk, Edinburgh EH **1 3AF**.

3

CHEMOTHERAPY

SECTION-1
ANTIMALARIALS

INTRODUCTION

During the present century, there has been an extensive research on chemotherapy of malaria and as a result, a large number of antimalarials have been developed. After screening thousands of chemical compounds for their antimalarial properties, safe and potent antimalarials were selected and marketed for treatment of patients suffering from malaria.

In retrospect, looking at the specific treatment of malaria infections, Quinghaosu is the oldest herbal preparation. Nearly a thousand years ago it was used in China for treating intermittent fevers.

Later on, **Quinine** was used all over the world as a chemotherapeutic agent for treatment of malaria. **Even now, it is still the drug of choice** for treatment of complicated *P.falciparum* infection. In 1638, Anna del Chinchon, wife of Viceroy of Peru, was cured of a fever episode, most probably due to malaria, by an extract from the bark of a tree which was being used by local tribals as a cure for fevers in Peru. There is a romantic anecdote which tells how the name of Lady Chinchon was misspelled as 'Cinchona' and the tree was named after her because of specific cure achieved in her case.

The Cinchona bark was introduced in Europe around the year 1643. Since then, it has been extensively used for treatment of intermittent fevers and has been recognised as a specific remedy for these fevers. Later on, after the discovery of malaria parasite, it was found to have action on all species of *Plasmodium*. In 1820, active alkaloid Quinine was isolated from Cinchona and was found to be superior in treatment of malaria cases as compared to Cinchona decoction-Totaquina. For nearly three centuries Quinine was the only chemotherapeutic agent available for specific treatment against malaria parasite infections. The Cinchona tree was brought by Portuguese and plantations were established in Jawa, India and parts of Africa. Nearly 90% of the supplies of Quinine came from these plantations. During World War I and II, the supplies from these plantations were cut off from one of the warring groups. Under field conditions, all troops were exposed to high risk of malaria. **It was observed that more often than not, an outcome of the battle was decided by the disability due to malaria rather than the lack of weaponry. This situation generated intense interest in developing synthetic antimalarials.** Thus it is apparent that just as malaria historically shaped the outcome of the World Wars, so also these Wars determined the approach to malaria chemotherapy.

Acridine dyes were found to have some effect on malaria parasite. After testing many chemical compounds of this group i.e. 9-Aminoacridines, **Mepacrine** was thought to be superior to Quinine in its action against malaria parasite. Prolonged

chemoprophylaxis with Quinine produced many adverse effects, some of them were quite serious and disability was sometimes permanent. Tinnitus, deafness, dizziness, ocular and cardiac symptoms were some of the worst side effects. Due to these serious and debilitating side effects, drug compliance by the patients was poor, both during chemoprophylaxis and treatment of acute episodes of malaria. On the other hand, it was found that Mepacrine produced comparatively milder side effects. Since the drug was deposited in the skin and gave a strange yellow colour to the skin of soldiers taking suppressive treatment, it was not very popular with persons put on chemoprophylaxis. The adverse reactions of Mepacrine were mostly gastro-intestinal disorders, skin discolouration and eruptions.

Due to adverse reactions of Mepacrine, further research was continued and as a result **Biguanide group of drugs became available in 1944.** They were found to be less toxic but equally effective in control of malaria infection. However, when Paludrine was used for chemoprophylaxis over a long period specially in troops or among tea garden labour of India, there were reports of drug resistance within a short period of time. **Diaminopyrimidines** were also synthesised during the same period and were found to have adequate antiparasitic action but this group showed greater adverse reactions when used as a long-term prophylactic/suppressive agent. **Much earlier than any of these drugs, 4-aminoquinolines were synthesised but were put on the shelf due to a misconception that antimalarial activity of this group of compounds was much lower than that of 8-aminoquinolines and Mepacrine.** One of the 8-aminoquinolines to be synthesised in 1920 was Primaquine. This drug was also not brought in general use till 1952. Earlier when it was used as a schizonticidal drug, its action on asexual erythrocytic stages of malaria parasite was found to be slow and the high chemotherapeutic doses administered for schizonticidal action produced adverse side effects. Thus its use as schizonticidal agent was stopped. During the intervening period, its effectiveness against the persistent tissue phase and gametocytes was recognised and since then it is being exclusively used as an anti-relapse and gametocytocidal drug for radical cure in malaria infections.

The **Sulfonamides** like Sulfadiazine were available in 1930. Later on in 1950s, the long acting Sulfa group of drugs were introduced. Large number of antibiotics were tested and a few of them were found to have specific action on malaria parasite but in the therapeutic doses recommended and tolerated, their action was found to be slow. Treatment with antibiotics had to be continued for a longer period i.e. 7 to 10 days as compared to the single day or three days Chloroquine regimen.

Chloroquine remained supreme in treatment of acute malaria episodes because of its fast action on parasites and antipyretic property which produced quick remission of fever and parasitaemia.

The review of the research on development of antimalarials shows that search for new antimalarials did not have the same urgency as was felt during I and II World Wars, mostly due to the fact that in Chloroquine and Amodiaquine, safe and fast acting antimalarials were available. The properties of these compounds were reassuring and the need for further research was not felt very urgent, more so because the resistance to these drugs in human parasite did not develop quickly and experts believed that like Quinine the resistance to these drugs would not develop soon. However, resistance to Chloroquine in *P.falciparum* was recorded in two widely apart epicentres in Latin America in 1960 and along Thai-Kampuchia border during 1962. **Nearly simultaneous emergence of resistance to Chloroquine in *P.falciparum* in two different ecosystems instilled a sense of urgency for developing newer antimalarials.** Thereafter, several chemical compounds have been tested for their antimalarial activity and new combinations like long acting Sulfa group of drugs with Pyrimidines (a combination which is extensively used since 1950), Dapsone, etc. and drugs like Mefloquine and Halofantrine have been found to be effective. These drugs are very effective for treatment of Chloroquine resistant *P.falciparum* strain. Long acting Sulfa group of drugs alone have very little and slow action on malaria parasite. Their action is potentiated in combination with Diaminopyrimidines. After 1950, their use as a second line of treatment in *P.falciparum* malaria infections resistant to Chloroquine was recognised.

However, most of the synthetic antimalarials marketed for treatment of Chloroquine resistant *P.falciparum* infection do select out resistant strains of *P.falciparum*. Such strains also show cross resistance to compounds of related groups. Thus there is a sense of greater urgency to develop new antimalarial compounds as well as to rationalise the use of existing antimalarials. Development of a new compound, its testing and ultimate marketing take a long time. The period may extend as long as 8 to 10 years or more. Therefore, malariologists all over the world are worried and they are trying to rationalise the chemotherapeutic approach to malaria cases.

In the meanwhile Chinese scientists started looking at their traditional medicines used for treatment of malaria so as to develop alternative drugs for treatment of Chloroquine resistant *P.falciparum*. They isolated active ingredients from their traditional herb Quinghaosu and drugs like Artemisinin, Artemether and Artesunate were tested for their efficacy against malaria parasites. These compounds are highly active against asexual erythrocytic stages of all species of human malaria parasites. It has been found that they are safer than Quinine or Chloroquine but have no action on sexual stages or tissue phase of malaria parasite in human beings. The major drawback is that a large number of breakthroughs occur in *P.falciparum* cases treated with Quinghaosu derivatives.

As the primary objective of malaria chemotherapy is to provide prompt clinical and parasitological relief to the person suffering from malaria, most of the antimalarials are evaluated and utilised on the basis of their action against asexual erythrocytic forms of malaria parasite because these stages of parasite are responsible for the clinical attack. On the other hand, some drugs have poor/slow schizonticidal action but are essential for treatment of malaria infection on account of their specific action against 'hypnozoites' and 'gametocytes' of malaria parasite.

CLASSIFICATION

Most of the antimalarials can be classified either according to their effect on different stages of malaria parasite or on the basis of their chemical nature. The list of antimalarials according to the chemical groups is given in Table- 3.1:-

Table-3.1: Antimalarial Drugs - Chemical Groups

CINCHONA ALKALOIDS
Quinine
Quinidine

DIAMINOPYRIMIDINES
Pyrimethamine
Trimethoprim

9-AMINOACRIDINES
Mepacrine

8-AMINOQUINOLINES
Primaquine
Pamaquine
Quinocide

BIGUANIDES
Proguanil
Chlorproguanil

4-AMINOQUINOLINES
Chloroquine
Amodiaquine

SULFONES
Dapsone

SULFONAMIDES
Sulfadimethoxine
Sulfamethoxypyridazine
(Sulfalene)
Sulfadoxine

ANTIBIOTICS
Tetracycline - Norfloxacin
Doxycycline - Ciprofloxacin
Minocycline - Ofloxacin
Clindamycin

NEW COMPOUNDS
Mefloquine
Halofantrine
Quinghaosu and its derivatives,
Artemisinin - Artemether,
Artesunate - Arteether,

Action of Antimalarials on Different Stages of *Plasmodium*

It is essential to understand the classification of antimalarials on the basis of their action on different stages of malaria parasite because this property of an antimalarial compound helps in formulating a rational chemotherapeutic approach towards treatment of malaria.

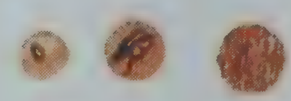
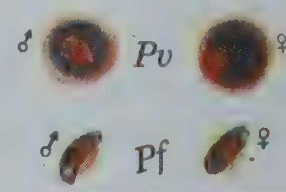
The malaria infection in human beings starts with the introduction of sporozoites in the human body from an infective mosquito bite. Some of the sporozoites are killed by phagocytosis but a large number of them manage to survive. They enter the liver cells - the 'hepatocytes' and undergo further development. The sporozoites remain in blood circulation for a period of nearly half an hour. During this period of their free circulation in the human body, the sporozoites are metabolically dormant. Probably due to this reason, none of the antimalarials are picked up by them and these chemical agents have no action on sporozoites while they are freely circulating in blood. **Drugs which prevent establishment of infection in a human being are called true causal prophylactic. There is no true causal prophylactic antimalarial for malaria infection so far.**

The sporozoites after entry into hepatocytes develop as tissue schizonts. Some of the sporozoites go into a dormant stage called 'hypnozoites'. They remain dormant in the hepatocytes for varying periods of time depending on the strain characteristics of *P.vivax* or *P.ovale.* **During the tissue phase i.e. primary tissue phase and hypnozoite stage, some of the antimalarials show adequate activity. These drugs belong to Biguanide, Pyrimidine and 8-aminoquinoline series.** Out of these groups, only 8-aminoquinolines show profound action against hypnozoites.

After a period of development and multiplication of parasites in hepatocytes, the merozoites are released in the blood stream. They infect the circulating RBCs. The erythrocytic stages of malaria parasite i.e. the various stages of the erythrocytic schizogony are affected by antimalarial compounds belonging to Quinoline, 4-aminoquinolines groups, Sulfonamide in combination with Pyrimidines, Antibiotics, Mefloquine and derivatives of Quinghaosu.

These groups of drugs have very little action on sexual stages of erythrocytic cycle of malaria parasite. **Only 8-aminoquinolines have action on mature gametocytes.** It has been inferred that 4-aminoquinolines have action on developing stages of gametocytes and the presumption seems to be valid because Chloroquine acts during the developmental stages of parasite by interfering with the utilisation of haemoglobin by the parasite, thus actively interfering with the metabolism of the parasite. Therefore, it can be postulated that those stages of malaria parasite will be affected by Chloroquine which are metabolically active. The metabolically dormant stages like sporozoites, mature gametocytes, hypnozoites, free circulating merozoites and mature schizonts will not respond to conventional antimalarials. Classification of antimalarials on the basis of their action on different stages of malaria parasite in human body is given in Table - 3.2.

Table-3.2: Classification of Antimalarials on the Basis of their Action on Different Stages of Malaria Parasite

SPOROZOITES	TISSUE PHASE		ERYTHROCYTIC STAGES	
			SCHIZOGONY	SEXUAL STAGES
	PRIMARY TISSUE PHASE 	PERSISTENT TISSUE PHASE HYPNOZOITES 	RING TROPHOZOITE SCHIZONT 	
No drug available	**BIGUANIDES** -Proguanil -Paludrine (in *Pf*) -Chlorproguanil **PYRIMIDINES** -Pyrimethamine -Trimethoprim (in *Pf*) **8-AMINOQUINOLINES** -Primaquine (Both in *Pv* & *Pf*)	**8-AMINOQUINO-LINES** -Primaquine	**QUINOLINES** -Quinine **4-AMIONOQUINO-LINES** -Chloroquine -Amodiaquine ****SULFONAMIDES** -Sulfadoxine -Sulfalene -Sulfamethaxazole **ANTIBIOTICS** -Tetracycline -Doxycycline **OTHERS** -Mefloquine -Qinghaosu and its derivatives -Artemisinin -Artemether -Artesunate -Arteether -Halofantrine	**8-AMINOQUINOLINES** -Primaquine ***4-AMINOQUINOLINES** -Chloroquine **OTHERS** # -Pyrimethamine # -Proguanil
True causal prophylactic	Causal prophylactic	Anti-relapse (Radical cure)	Schizonticidal (also used as Suppressant)	Gametocytocidal

Sprontocidal (in *Pv* & *Pf*)

* Action against gametocytes of *P.vivax*, also active against developing gametocytes of *P.falciparum*

** This group has very little or negligible action on asexual stages of *P.vivax*.

Action of long acting Sulfonamides is potentiated in combination with:-

- Pyrimethamine

- Trimethoprim

- in proportion of 20:1 and 8:1 respectively

DETERMINANTS OF ANTIMALARIAL DRUG EFFICACY

The efficacy of an antimalarial drug depends on:-

- rate of absorption on oral administration

- time taken to achieve therapeutic levels of drug concentration in blood

- duration of chemotherapeutically effective blood concentration

- their storage in body tissues

- their ability to bind with proteins, especially plasma proteins

- their rate of conversion into metabolites

- their rate of excretion

- their preferential concentration in infected RBCs

- their action on different metabolic systems of malaria parasite. They may act as antimetabolic agents thereby interfering with supply to, or use by the parasite of nutrient amino acids/enzymes, or they may have action on RNA/DNA affecting its replication or other functions Thus these antimalarial drugs destroy the parasites by interfering with their development or multiplication. Some of the antimalarial drugs act as antimetabolic compounds by interfering with dihydrofolate reductase (DHFR) inhibitors such as Pyrimethamine.

- toxicity to humans as some drugs are more toxic to people having certain genetic abnormalities notably G6PD deficiency. The genetically defective red blood cells are more readily haemolised by 8-aminoquinolines such as Primaquine.

- and for reasons not well understood, some drugs are more effective against one species of parasite than the other. In this group are Sulfone and Sulfonamides. They act against *P.falciparum* but have very little action on other species of malaria parasite.

Mechanism of Antimalarial Activity

The mechanism of antimalarial activity of the four groups of compounds is discussed below:-

The first group consists of Quinine and related group of compounds which include Chloroquine, Amodiaquine, Quinine and Mefloquine. These drugs act as very effective **schizonticidal** agents. In case of Chloroquine, it has been observed that the drug concentration is 7 to 8 times more in RBCs than in plasma. It is much more in those RBCs which are parasitised. In case of resistant strain, the concentration in parasitised RBCs is lower than what is observed in non-resistant strain infection. One of the hypotheses is that there is an active efflux of drug from RBCs infected with resistant strain. The drug interferes with haemoglobin digestion preventing parasite from using the required nutrients. The drug gets concentrated in parasite acid vesicles, raises intracellular pH and thus inhibition of acid proteases occurs. The alkaline environment is disturbed. The drug acts on RNA and DNA of the parasite. The amino-acids essential for parasite growth are blocked by this drug.

Quinine acts by similar mechanism and also indirectly by producing lysis of parasitised red blood cells. The lysis of red blood cells results in casting out the immature parasites which are subsequently destroyed by defence mechanism of the host.

The second group includes Sulfones and Sulfonamides which act as **PABA inhibitors**. These drugs act as anti-metabolites preventing the parasite from making dihydrofolate, an essential enzyme for its nuclear division. The parasite may survive the action of the drug if it has the capacity to utilise an alternative enzyme system.

The third group of drugs which are **DHFR inhibitors** includes Pyrimethamine, Proguanil and Trimethoprim. These anti-metabolites have high affinity for the enzyme dihydrofolate reductase. These drugs remove the reductase thereby interfering with nuclear division of the parasite.

The fourth group of drugs have **Action as**

Parasite Membrane Disrupters i.e. anti-nuclear, includes the traditional Chinese herbal preparation - Quinghaosu (Artemisinin, from the herb *Artemisia annua* and its derivatives-Artemether and Artesunate) which act through their anti-sesquiterpene peroxide structure and generation of free radicals. Damage occurs to parasite nuclear and cellular membranes, mitochondria and food vacuole; autophagic vacuoles then appear and the parasite disintegrates. The destructive action is more rapid than that of Chloroquine or Quinine.

Physician's Option

Out of a large number of antimalarial compounds available for treatment of malaria, the Physician while treating a malaria case has to decide the drug of choice and the options available are decided on the basis of:-

i. The route of administration - oral, intramuscular, intravenous,

ii. Rapidity of abortion from the route of administration,

iii. Time taken to attain therapeutically effective blood concentration,

iv. Half life of the drug,

v. Excretion time/rate,

vi. Adverse reactions such as idiosyncrasy, chronic toxicity on prolonged use,

vii. Contraindications and

viii. Precautions to be observed as well as the efficacy of antidotes available for treatment of acute or chronic toxicity and

ix. Nursing care required/available if adverse reactions are encountered.

General Rules of Antimalarial Therapy

Before the details regarding the mode of action, dosage, etc. of different antimalarials are discussed, it is necessary to lay down some ground rules for use of antimalarials. These rules will help the physician in choosing appropriate treatment schedule for a patient suffering from malaria.

i. Oral administration of antimalarials should be preferred in all cases who can swallow and retain antimalarial compounds, as most antimalarials are absorbed rapidly.

ii. Intravenous antimalarials like Quinine or Artemisinin should be used in comatose patients or patients who cannot retain and vomit out antimalarials administered orally usually due to gastro-intestinal irritation.

iii. An antimalarial with good chemo-therapeutic index (difference between clinically effective and toxic dosage) should be chosen for oral and parenteral administration.

iv. Chloroquine is the drug of choice for treatment of infections with *P.vivax*, *P.malariae* and *P.falciparum* malaria parasites.

v. Only in case where infection with *P.falciparum* strain resistant to Chloroquine is suspected, other antimalarials should be used.

a. In ambulatory cases of *P.falciparum* resistant strain without complications, long acting Sulfa-Pyrimethamine combination is the drug of choice.

b. In severe and complicated malaria cases, intravenous Quinine should be administered.

vi. Internationally accepted dosage should be strictly adhered to, so that future complications and toxic manifestations are avoided.

vii. While administering the intravenous Quinine, patients should be carefully monitored for hypoglycemic crisis and cardio-vascular complications. The arrangements should be made for appropriate investigations and suitable supportive treatment.

PROPERTIES AND USE OF ANTIMALARIAL COMPOUNDS

Cinchona Alkaloids

Quinine or Quinidine are Cinchona derivatives. At present their synthesis is expensive and commercially not feasible. Quinidine can be used as an alternative, if Quinine is not available. Cardiac side effects are more common. Therefore strict cardiac monitoring is essential with the latter.

Quinine

i. Formulations Marketed

Quinine is available as dihydrochloride salt for intramuscular or intravenous injection. Each ampule of 2 cc contains 600 mg of Quinine salt i.e. 300 mg per cc.

Three salts of Quinine are marketed for oral administration i.e. Sulfate, hydrochloride and dihydrochloride as tablets, each tablet contains 300 mg of Quinine salt.

ii. Dosage

a. Oral Administration

Adult Dose

600 mg Quinine salt three times a day for seven days (10 mg Quinine salt per kg body weight 8 hourly for seven days).

Children can tolerate higher dose of Quinine i.e. 10 mg per kg body weight for four days followed by 15 mg per kg body weight for subsequent three days.

b. Intramuscular Injection

10 mg per kg/body weight at 8 hourly intervals. Quinine preparation is adequately diluted with normal saline. If intramuscular injection is unavoidable, it should be given deep intramuscularly. If after dilution, the quantity of injectable solution is more, it should be distributed at multiple sites.

Intramuscular Quinine injection should be given very carefully in gluteal muscles ensuring that injected fluid does not lie near the arterial or neural plexus, as it may lead to arterial spasm resulting in necrosis and gangrene in the area of its supply. Subsequent fibrosis may lead to paralysis of the limb/muscle supplied by the nerve enmeshed in fibrosis. As most of the patients of malaria suffer from malnutrition and muscles are emaciated, it is not advisable to give intramuscular injection. If unavoidable it should be given in the front muscles of the thigh. Any subcutaneous leak will lead to necrosis of subcutaneous tissue and skin.

c. Intravenous Injection

600 mg (adult dose) (10 mg/kg body weight) to be given as I.V. infusion over a period of 4 hours. The dose is repeated at 8 hourly interval, in 24 hours not more than 1800 mg is given. Quinine should be added to 5% glucose infusion. Loading dose of 7 mg/kg body weight in 200 cc of 5% glucose can sometimes be given over 30 minutes.

iii. Absorption and Blood Concentration

Orally administered Quinine is quickly absorbed from upper intestinal tract and peak concentrations are attained in one to three hours. The absorption from intramuscular injection is sometimes erratic in a serious and complicated case of *P.falciparum* with peripheral circulatory disturbance and the peak concentration time is variable.

With intravenous infusion of 7 mg per kg body weight over 30 minutes or 10 mg per kg body weight over a period of 4 hours, peak concentration is quickly attained.

iv. Duration of Action

The action on parasites starts immediately. Half life of Quinine is 16 to 18 hours. **In children half life is shorter i.e. five hours and can cause therapeutic failure.** Therefore, the dose is to be repeated at 8 hourly interval. **If a patient remains seriously ill after third day, intravenous dose should be reduced to avoid toxicity.**

v. Excretion

Quinine is completely excreted within 24 hours. The excretion is slow in case of renal insufficiency/failure and acute hepatitis. If these complications are suspected, the dose of Quinine should be carefully regulated.

Quinidine

Quinidine behaves almost like Quinine. Loading dose is 24 mg per kg body weight followed by 8 hourly maintenance dose.

Special Considerations

- Both these drugs cross blood brain barrier

and are found in cerebro-spinal fluid. The concentration is nearly 7% of the concentration observed in the plasma.

- The blood sugar levels should be monitored regularly in all cases under treatment with Quinine, especially in patients treated with intravenous/intramuscular Quinine administration.

- The cardiac condition should be monitored for adverse effects. However, cardiac complications are not serious in prescribed dosage.

a. Oral Administration:-

i. Adverse Reactions

- Rare after oral administration; usually the following may be observed.

- Gastric irritation, nausea, giddiness, ringing in the ear (tinnitus), tremors and blurred vision may occur in some patients during the first few days of treatment.

- Idiosyncrasy is seen in some patients but it is rare.

- Symptoms like urticarial or erythematous rashes, itching, subcutaneous or submucous haemorrhages, oedema of eyelids and mucous membrane of lungs; collapse may sometimes follow a single dose.

- Haemoglobinuria and anuria may occur in rare cases of overdose or idiosyncrasy.

- There is good evidence that those *P.falciparum* patients who are exposed to repeated reinfections and have been treated with inadequate doses of Quinine, later on when given even a small dose of Quinine develop severe haemoglobinuria - the mechanism of the haemolytic syndrome is obscure, though it is probably due to an autoimmune process somehow triggered by Quinine.

- Very rarely unexplained fever occurs or continues after parasitological cure.

ii. Acute Poisoning - Symptoms

- Quinine amblyopia

- Shock

- Hypotension

- Depression of central nervous system, respiratory distress and cardiac arrest.

iii. Chronic Toxicity

On prolonged use of Quinine, the following chronic toxic symptoms are encountered.

- The symptoms of toxicity & adverse reactions as given above are more pronounced.

- Sudden amblyopia, contraction of field of vision.

- Serious impairment of hearing leading to deafness was observed in babies born from mothers who had taken toxic doses of Quinine.

iv. Precautions

- Skin test to detect idiosyncrasy

- Drug should not be administered on empty stomach

- Irregular use should be avoided

v. Remedy

In case of adverse reactions and acute toxicity:

- Immediate withdrawal of drug

- Symptomatic treatment

vi. Treatment

- Gastric lavage with solution of magnesium sulfate (250 ml at a time, of the solution of 100g magnesium Sulfate per litre of water). After lavage it is recommended to leave a dose of 15-30 g magnesium Sulfate in the stomach.

- Artificial respiration

- Parenteral administration of ephedrine hydrochloride or amphetamine.

- Intravenous fluids

If the patient can be kept alive for 24 hours, a fatal outcome is generally averted

- To control ocular disturbances - either

nicotinic acid 50 - 200 mg Papaverine 30-60 mg or sodium nitrate 100 mg is given parenterally. **These drugs should not be given when the patient is in shock.**

vii. Contraindications

- Drug idiosyncrasy

- History or threat of black water fever

Note: Some physicians do not like to useI.V. or oral Quinine in pregnant women because of its abortificant property. However, in recommended doses in women who have no idiosyncrasy, the chances of abortion with Quinine are negligible. On the other hand, malaria infection can more often precipitate abortion on account of foetal hypoxia.

b. Intramuscular Route

i. Adverse Reactions

- Fibrotic induration at the site of injection; lasts for a long time.

- Sterile/infected abscess at the site of injection is more common, if proper aseptic care is not taken. **This complication is more often observed with Quinine dihydrochloride as compared to Quinine hydrochloride**

- Giddiness, tinnitus, tremor, blurred vision, idiosyncrasy, etc.

- Other symptoms as observed with oral administration may also appear

- Skin necrosis if there is a subcutaneous leak.

- Gangrene and paralysis of area supplied by the artery and nerves if the injected fluid enters the sheath of arterial or neural plexus.

With proper precautions the risk of intramuscular injection is reduced but not eliminated. It is not recommended in diabetics and persons having concomitant bacterial infection / septicaemia

ii. Precautions and Remedy

- Proper aseptic measures to be taken to avoid development of problem at the site of I.M. injection.

- Skin-test to eliminate Quinine idiosyncrasy.

- Stoppage of subsequent injections if symptoms develop.

- Symptomatic treatment as indicated under oral administration.

- In case an arterial spasm occurs, the fingers or toes supplied by the artery turn blue and are painful. Sometimes there is shooting pain along the course of the artery or nerve involved. The site of the injection should be opened and the surrounding tissue should be irrigated with normal saline and dressed with antibiotics and cortisone. Administer peripheral vasodilator to relieve arterial spasm. Other symptomatic treatment should be given as required.

c. Intravenous Route

i. Adverse Reactions

- Solutions of Quinine are caustic and if any subcutaneous leakages occur when vein is missed or there is a counter puncture it will cause intense pain followed by necrosis of subcutaneous tissue and skin.

- Hypotension.

- Fatal collapse as a result of intravenous injection if given too quickly without proper dilution.

ii. Precautions and Remedy

- Intravenous injection should be given slowly over a period of 4 hours by drip. Daily dose should not exceed 1800 mg in 24 hrs in adults and proportionately adjusted in children.

- Symptomatic treatment for other toxic reactions as indicated under oral administration.

To an adult Quinine dihydrochloride 420 mg (7 mg /kg body weight) in 200 cc of sterile pyrogen free physiological saline or glucose 5 % to be given intravenously in 30 minutes with infusion pump as a loading dose but it is rarely required and should be avoided.

4-Aminoquinoline Compounds

Chloroquine

i. Formulations Marketed

Chloroquine is available as Sulfate and phosphate salt both for oral and parenteral administration.

- Injectable Chloroquine available both in ampules and vials, the preparation usually contains 40 mg base per cc.

- Each tablet contains 150 mg Chloroquine base. The weight of Sulfate and phosphate salts in the tablets differs. A Chloroquine phosphate tablet of 250 mg and that of Chloroquine Sulfate of 200 mg contains only 150 mg of Chloroquine base.

ii. Dosage

a. Oral Administration

Oral administration is carried out in an adult with a single dose of 600 mg or 1500 mg in three daily dosages of 600 mg each on day 1 and day 2 and 300 mg on day 3 - i.e. @ of 10 mg per kg body weight each on first and second day and 5 mg per kg body weight on third day.

b. Intravenous Administration

Chloroquine is given as I.V. infusion at the rate of 5 mg base/kg body weight over a period of 4 hours. The total dose should not exceed 15 mg/ kg. body weight over 24 hrs.

Several dosage schedules for I.V. administration of Chloroquine have been recommended by different authorities. On account of the danger of cardiac toxicity, the above schedule is considered safe and effective.

c. Intramuscular Administration

Chloroquine 3.5 mg base per kg body weight is given at 6-8 hourly interval. However, the intramuscular administration of Chloroquine is not advocated because of its erratic absorption from the site of injection in a seriously sick case.

The sudden rise in blood concentration of Chloroquine usually produces equally abrupt severe hypotension and collapse. This reaction is more often observed in children than in adults.

If it is a must to give I.M. Chloroquine, it should be given in two divided doses and blood pressure should be monitored

iii. Absorption and Blood Concentration

Chloroquine is readily absorbed after oral administration. The therapeutic concentration is attained within 2 hours. Serum concentration of 15 to 30 µg per litre is minimal inhibitory concentration for *P.vivax* and *P.falciparum.* A dose of 10 mg per kg body weight produces concentration up to 250 µg per litre within 2 hours. With half life of 10 days, concentration once achieved is therapeutically active for 3 to 5 days.

iv. Distribution in Tissues

It is bound to proteins of tissues like spleen, liver, kidney, heart and lungs. Concentration in RBCs is higher than concentration in serum. It crosses transplacental barrier and is also excreted in milk.

v. Duration of Action and Excretion

Chloroquine excretion is very slow. Its average half life is 10 days and may vary from 75 hours to 2 months. It can be detected in urine up to 120 days after administration of a single dose. The absorption from intramuscular site is very rapid in patients without serious complications. Even with a dose of 5 mg/kg body weight, transient high serum concentration can occur and cause serious complications.

vi. Caution

- **Chloroquine has narrow therapeutic index. The lethal single oral dose in infants and toddlers is 1 gm and in case of adults it is 4 gms. Therefore, the drug intake should be carefully monitored.**

- The toxicity is nil/minimal at the recommended dose for oral administration.

- The drug is extremely bitter. Therefore accidental overdose is rare.

- Due to bitter taste it is difficult to administer the drug to infants and young children. Care should be taken not to force the tablet down

the throat to avoid accidental asphyxiation.

vii. Adverse Reactions

- Gastric irritation, nausea, vomiting, abdominal discomfort, diarrhoea, headache, pruritis, blurring of vision and hypotension.

viii. Reactions in Hypersensitive Persons

- Other rare reactions like dyskinesis, hearing loss, neuromuscular disorders, photo-sensitisation and even cardio-vascular disturbances are observed.

ix. Chronic Toxicity

Prolonged use of large dosage of Chloroquine for weeks or months causes:-

- Ocular damage like neuro-retinitis.
- Pigmentation of skin, nail-bed and palate.
- Neutropenia, specially after long continued use.
- Skin rashes.
- Hypotension.

x. Precautions and Remedy

- Drug should not be administered on empty stomach.
- It should be taken only after a meal.
- The mild adverse symptoms usually disappear soon after administration of drug is discontinued.
- The ocular changes are usually irreversible.

xi. Treatment of Overdose

- Supportive treatment.
- Gastric lavage if patient is not in comatose or in convulsions. Activated charcoal 60-100 gm after lavage.
- Airway protection, assisted ventilation.
- Diazepam up to 10 mg I.V. slowly if cerebral stimulation is present.
- I.V. fluids, Dopamine 200 mg in 500 ml saline, start with 2-5 µg/kg/min.
- Forced diuresis and/or urinary acidification increases excretion. Furosemide - 20 mg or as required up to 500 mg I.V. or I.M. as considered appropriate.
- Charcoal haemoperfusion in severely toxic patient is beneficial if done at very early stage.

Intramuscular or intravenous use of Chloroquine as a routine is not advised because of serious side effects and toxicity such as sudden collapse and hypotension.

Amodiaquine

This compound has action similar to Chloroquine.

i. Formulation Marketed

Amodiaquine is available in the market in the form of oral tablets and is extensively used for treatment of malaria cases by medical profession. The dosage for oral administration, its absorption, excretion, etc. are similar to that of Chloroquine.

Amodiaquine appears to retain antiparasitic activity against *P.falciparum* strains resistant to Chloroquine. However, this advantage is shortlived. Therefore, only for very short period of time, it can be used as a second line of drug for treatment of *P.falciparum* strains resistant to Chloroquine.

ii. Caution: Contraindicated for long-term use

The long-term use of Amodiaquine as a prophylactic drug is contraindicated because one of the metabolites of Amodiaquine, a quinoline, **produces acute toxic hepatitis and potentially lethal agranulocytosis. This complication occurs 1 in 2000 persons on Amodiaquine prophylaxis. The risk of mortality outweighs the risk of contracting malaria and subsequent mortality.** In India, Amodiaquine has been withdrawn from the programme since 1996.

8-Aminoquinoline Compounds

Primaquine

It is one of the compounds of 8-aminoquinoline group of drugs. It has a better chemotherapeutic index as compared to other compounds of this group. In the recommended doses, it acts against

hypnozoites of *P.vivax*, *P.ovale* and gametocytes of *P.falciparum* and other *Plasmodium* species. **Its action against persistent tissue phase of malaria parasite and gametocytes is unique among antimalarials and no other alternative is available.**

i. Formulation Marketed

It is marketed in the form of tablets of 2.5 mg and 7.5 mg. It is **never administered intravenously or intramuscularly** and in India no formulation is available for parenteral use.

ii. Absorption and Blood Concentration

It is rapidly absorbed from the gastro-intestinal tract. Bio-availability of the drug is about 74%. **Its therapeutic concentration in the blood is attained within three hours** and 150-200 µg per ml concentration is achieved with a single dose of 45 mg. The mode of action of the drug on hypnozoites and gametocytes is not very well known.

iii. Excretion

The drug is completely metabolised, has a half life of 6 to 8 hours and is completely excreted within 24 hours.

iv. Action

The treatment with Primaquine to achieve radical cure should be given after completing schizonticidal therapy with other antimalarials.

v. Dosage in Adults

P.falciparum	- 45 mg single dose (0.75 mg per kg body weight).
P.vivax	- 15 mg (0.25 mg per kg body weight) daily for 5 days.

(Some countries give the dose of 0.25 mg per kg body weight daily for 14 or 21 days).

- Some authorities recommend administration of 0.75 mg / kg body wt or 45 mg adult dose weekly for a period of 8 weeks in areas where G6PD deficiency is widely prevalent in local population or ethnic groups. This schedule is considered adequate to achieve radical treatment in cases of *P.vivax*.

vi. Adverse Reactions

At the recommended dosage, adverse reactions are not likely to occur.

- Anorexia, nausea, vomiting, epigastric distress, abdominal pain and cramps have been observed.

- Passage of dark coloured urine, dyspnoea (difficulty in breathing).

- Methaemoglobinaemia (manifested by cyanosis of nail-beds, lips, earlobes, tip of nose and tongue).

- More severe toxic manifestations occur in some patients. The haemolytic action of Primaquine is related to the presence of hereditary enzyme deficiency, particularly that of Glucose-6 - Phosphate Dehydrogenase (G6PD), leading to haemoglobinuria and renal failure.

vii. Chronic Toxicity

In addition, there may be bone marrow depression after prolonged use or in cases sensitive to this drug

- Anaemia, leucopenia.

viii. Remedy

- The above manifestations disapear when the drug is withdrawn

- Patient should be removed immediately to the Primary Health Centre. If not controlled the case should be transferred to a referral hospital. In acute and serious cases delay in proper management can be fatal.

ix. Contraindications and Precautions

a) Known G6PD deficient patients, b) Infants because foetal haemoglobin is more sensitive to 8- aminoquinolines, c) Pregnant women, who are high risk groups - Primaquine crosses placental barriers and is likley to react adversely with foetal haemoglobin leading to foetal distress, abortion or death, d) patients with tendency to granulocytopenia.

Primaquine should not be administered on empty stomach to the eligible patients.

x. Poisoning and its Treatment

- Symptoms may be any one of the listed above.

- Symptomatic treatment like regulation of fluid intake, in case of anurea diuretics-Furosemide 20 mg I.V. or I.M. or as required up to 500 mg in 24 hours.

- In case of acute haemolysis with low Hb% and R.B.C. count, blood transfusion.

- If kidney failure is observed, dialysis should be carried out.

- Supportive treatment like administration of oxygen and I.V. fluids is carried out whenever required.

In acute or chronic toxicity folinic acid at a dose of 10-20 mg daily should be given.

Sulfonamide and Pyrimethamine Combinations

There are three long acting sulfonamide compounds namely:-

1. Sulfadimethoxine
2. Sulfamethopyridazine (Sulfalene)
3. Sulfadoxine

The sulfonamides *per-se* have very little action on malaria parasite. **In combination with Pyrimethamine in ratio of 20:1 the antimalarial action of both components is potentiated.** Comparatively the combination is highly active against *P.falciparum*, but has very little action on *P.vivax, P.ovale* and *P.malariae*. Their schizonticidal action is slower than that of Quinine, Chloroquine or Artemisinin derivatives.

- **This drug combination is used as a second-line of drug for treatment in case of resistant strains of *P.falciparum*.**

Combination of long acting Sulfa and Trimethoprim is not advocated for use in treatment of malaria cases because of wide disparity in the half life of long acting Sulfa and Trimethoprim.

i. Formulation Marketed

In India it is marketed as oral tablets with different brand names. It is not available in preparation for intramuscular or intravenous administration.

ii. Dosage

The drug is administered orally to achieve clinical and parasitological cure and that too only in case of *P.falciparum* infection. A single dose (adult) of 1.5 gm is advocated with 75 mg Pyrimethamine.

The age-wise dosage for radical treatment is given in page 83 & 84.

iii. Absorption and Blood Concentration

Sulfalene (Sulfamethoxypyridazine) and Sulfadoxine are absorbed from the gastro-intestinal tract. Chemotherapeutic blood concentrations are achieved in 4 to 6 hours. Comparatively they have slower action on malaria parasite.

iv. Excretion

The half life of Sulfalene is 65 hours and of Sulfadoxine 120 to 200 hours.

The other component of the combination i.e. Pyrimethamine is readily absorbed from the gastro-intestinal tract. Its antimalarial action is similar to Chlorguanide, but its potency is greater. Half life is 80 to 95 hours. Therefore, Sulfalene or Sulfadoxine and Pyrimethamine combinations are preferred for treatment of *P.falciparum* malaria.

Diaminopyrimidines

Pyrimethamine

Apart from the description given above, further aspects are covered below:-

i. Adverse Reactions

- At the recommended dosage the toxicity is very low. Long term administration of Pyrimethamine may result in:-

- Gastro-intestinal disturbances, ulceration of mouth, loss of hair, anaemia.

ii. Remedy

- Immediate withdrawal of the drug.

- Administration of Folinic Acid: 10-15 mg daily.

iii. Contraindications and Precautions

Use of pyrimethamine alone is contraindicated because of rapid development resistance in *Plasmodium*

- In areas where parasite is resistant to Pyrimethamine, it should not be used alone but should be used in combination with long acting Sulfa. +Pyrimethamine should never be administered on empty stomach.

iv. Acute Poisoning

- **Acute poisoning has been reported in children who have consumed large number of tablets (100 mg to 250 mg) because of its tastelessness.**

a. Symptoms

- convulsions

- loss of consciousness, collapse and sudden hypotension with fatal outcome.

b. Treatment

- Gastric lavage, 5-10 mg Diazepam given slowly by intravenous or intramuscular injection, folinic acid 10-20 mg daily.

Sulfonamides

Long Acting Sulfonamides

Combination of long acting Sulfa (like Sulfadoxine, Sulfalene) with Pyrimethamine is used in the areas of *P.falciparum* resistant to Chloroquine.

The above combination of drugs given in recommended dosage is generally well tolerated. However, the following adverse or toxic manifestations may be encountered.

i. Adverse Reactions

Gastro-intestinal disturbances like nausea and vomiting.

- Mild jaundice. Urticarial, erythematous, maculopapular morbilliform or purpuric skin rashes.

ii. Toxicity After Long Term Use

Haematological-granulocytopenia, agranulocytosis, aplastic anaemia, thrombo-cytopenic purpura,

- Steven - Johnson syndrome

Because of irreversible complications mentioned above, its use for chemoprophylaxis is contraindicated

iii. Remedy

- Immediate withdrawal of the drug.

- Plenty of fluid intake.

- Folinic acid at a dosage of 10-30 mg daily.

iv. Contraindications

- During first three months of pregnancy.

- Infants.

- Hypersensitivity to the drug.

v. Caution

- Long acting Sulfa should not be given on empty stomach.

- Should be given with caution to infants and pregnant women.

New Compunds

Mefloquine

Mefloquine is a compound of aminoquinoline-methanol group and is related to Quinine. It is a long acting and potent blood schizonticidal drug. It acts against all species of malaria parasite. It is preferentially used for treatment of *P.falciparum* strains resistant to Chloroquine. It is effective in a single dose.

i. Formulation Marketed

Mefloquine is available in 250 mg tablets for oral administration. There is no parenteral formulation of this drug and cannot be used as I.V. or I.M. injection since it is irritant to peripheral arteries and veins.

ii. Dosage

Dose of Mefloquine is 15 mg base per kg/body weight as a single dose i.e. three tablets (adult dose) are administered at a time (some countries use 1 gm base as a single dose in an adult for treatment of resistant strains of *P.falciparum).*

iii. Absorption

Mefloquine is absorbed from the gastro-intestinal tract, biotransformed in the body. **It does not cross blood brain barrier; therefore, it is not much suitable for treatment of cerebral malaria cases.**

The half life of the drug is 6 to 30 days or more. It is mainly excreted in urine. Nearly 5% is excreted in bile and faeces. It binds extensively with plasma proteins and thus it has a longer half life.

iv. Adverse Reactions

- Nausea, vomiting, diarrhoea, abdominal pain. More common if given in dose higher than 15 mg/kg body weight.

- Asymptomatic sinus bradycardia and marked sinus arrhythmia. Pulse rate decreases 3 to 4 days after drug administration and returns to normal within two weeks.

- Predictable sensation of light headedness often accompanied by dizziness and difficulty in concentration occurring within a few hours (4 - 6 hrs) after first dose and resolving within a few days.

- Rare reactions include myalgia, hair loss, visual disturbances, palpitation, feeling of weakness, erythema multiforme major, transient elevation of transaminases and granulocytosis.

- **More serious central nervous system side effects are abrupt psychosis, loss of consciousness or even generalised convulsions. It occurs in second week after starting prophylaxis and resolves during following two weeks if drug is stopped. The central nervous system reaction is not dose dependent, sometimes single dose can precipitate this reaction.**

v. Precautions

- Both Quinine and Mefloquine are cardiotoxic. Mefloquine concentration can rise abruptly after cessation of Quinine administration. Caution should be exercised when both drugs are used sequentially.

vi. Contraindications

- Mefloquine should not be used for prophylaxis in persons involved in tasks requiring fine co-ordination and spatial discrimination.

vii). Use in Pregnancy

- Its administration for treatment of acute malaria episode should be avoided in first trimester of pregnancy.

Fansimef

Mefloquine, Long Acting Sulfa and Pyrimethamine Combination

Initially the combination of Mefloquine, long acting Sulfa and Pyrimethamine was recommended for use because of its presumed superior action and in order to delay development of *P.falciparum* strains resistant to Mefloquine.

It was observed that this combination of Mefloquine and long acting Sulfa + Pyrimethamine had a number of serious adverse reactions like skin reaction, involvement of ocular system, gastro-intestinal disturbances as well as serious neuro-psychiatric complications of Mefloquine. The efficiency of this combination was more or less similar to Mefloquine alone without any other advantage.

This combination is no longer recommended either for treatment or prophylaxis of malaria infection.

As the combination of drugs should have a similar half life and since no other antimalarial drug has long half life of 30 days as Mefloquine, the next best combination of Sulfadoxine and Pyrimethamine was selected.

Halofantrine

The drug belongs to phenanthrenemethanol group. It was registered in 1988 for treatment of malaria.

It is effective against *P.falciparum* strains resistant to Chloroquine and Pyrimethamine +

Sulfadoxine. It has schizonticidal activity against all species of malaria parasite i.e. *P.falciparum, P.vivax, P.ovale* and *P.malariae*.

i. Formulation Marketed

The drug is marketed as tablets containing 250 mg. Halofantrine hydrochloride (233 mg. base). Intravenous or intramuscular preparation is not available.

ii. Dosage

Children	- 8 mg per kg body weight three times at 8 hourly interval.
Adult	- 500 mg or 8 mg/kg body weight three doses at 8 hourly interval.

iii. Absorption and Blood Concentration

It is completely absorbed from gastro-intestinal tract. Maximum plasma concentration is reached in 6 hours after a single dose. **Its absorption from the gastro-intestinal tract is erratic** probably due to its lipid solubility. Even with therapeutic dosage, the **peak plasma concentration levels are variable and cumulative toxicity has been observed with this drug, sometimes leading to a fatal outcome.** On account of the above behaviour of the drug, it is not recommended for treatment of complicated *P.falciparum* malaria cases. It has also shown cross-resistance to Mefloquine.

iv. Adverse Reactions

- Generally mild and transient, not requiring specific treatment
- Nausea, diarrhoea and abdominal pain (15-25%)
- Vomiting occurs approx. 1 hr after administration
- Orthostatic hypotension (33%)
- Prolongation of QT interval. It is a dose dependent effect
- Transient increase in serum transaminases

v. Contraindications

Pregnancy and lactating mothers

Qinghaosu Derivatives

Artemisinin is the name given to active principle of Qinghaosu *(Artemisia annua)*. It is poorly soluble in water and decomposes in other solvents. It is produced as dihydroartemisinin and commercially marketed.

i. Formulations:

Three formulations of the derivatives of Qinghaosu are as under:-

a. Artemether

Artemether is marketed as methylether of dihydroartemisinin. Oil preparation in one cc ampule containing 80 mg is available for intramuscular injection.

b. Artesunate

Artesunate is a water soluble derivative. It can be administered parenterally in aqueous solution. It is also marketed in tablet form containing 50 mg of the compound.

c. Arteether

It is similar to Artemether compound.

ii. Dose

1. **Artemisinin** - 500 mg daily for five days.
2. **Artesunate** - 60 mg at 0, 4, 24 and 48 hours.
3. **Artemether** - 80 mg daily dose - total of 480 mg over five days, first dose being double.

iii. Absorption and Blood Concentration

After intravenous administration, the peak concentration is achieved immediately. After oral administration, the peak concentration is attained within 1 hour. The half life of the drug is 45 minutes in case of Artesunate and up to 6 hours in case of Artemether. Because of short half life, repeated doses are required at frequent intervals.

The drug is not marketed in India and is not registered for use in the country. **Its efficacy lies in treatment of resistant strains of *P.falciparum* especially in cerebral malaria cases where its action is faster as compared to that of Quinine.** The drug should be used very cautiously. Although it is less toxic than Quinine, there is high recrudescence rate with the therapeutic schedule given above. It is likely that after extensive clinical trial in the field, its dosage schedule for treatment of Chloroquine resistant *P.falciparum* strains in India may undergo modification.

iv. Adverse Reactions

No significant clinical adverse effect was observed in more than 2000 malaria patients treated with the drug during field trials.

- Transient reduction in reticulocytes and neutrophil granulocytes, especially young forms

- Transient increase in transaminase

v. Use in Pregnancy

- Controversial

- **Contraindicated in first trimester; in animal experiments it was observed that there was foetal absorption in early pregnancy when pregnant animals were put on this drug.**

- **The data available in India regarding its side effects are not adequate.**

Table-3.3:- SUMMARY OF DOSAGES OF ANTIMALARIAL DRUGS

Name of Drug with Chemical Group	Year of Discovery	Year when used as an Antimalarial	Internationally accepted adult dosage	Half life
1	2	3	4	5
1. **CINCHONA ALKALOIDS**	Formula in 1908. Synthesised in 1948.	1940s	600 mg 3 times a day for 7 days 600 mg. I.V. or 4 hours. Repeated 10mg/kg body wt. over 3 times in 24 hours for CEREBRAL MALARIA	10 hrs
2. **BIGUANIDES**				
a. Proguanil	1944	1945	300 mg twice daily for 10 days	24 hrs
b. Chlorproguanil*	1960	1960s	20 mg daily	
c. Cycloguanil*	1965	1965	Injectable-140 mg/ml 2-2.5 ml intramuscular.	
3. **DIAMINOPYRIMIDINES**				
a. Pyrimethamine	Early 1940s	1952	50 mg daily for 3-4 weeks usually combined with other drugs.	96 hrs
b. Trimethoprim*	Late 1940s	1950s	-	16 Hrs
4. **4-AMINOQUINOLINES**				
a. Chloroquine	1934	Late 1940s	600 mg first dose after 6-8 hours 300 mg followed by 300 mg daily for next 2 days. **Alternatively -** 600 mg first day 600 mg second day 300 mg third day	3-7 days (traces found in urine) up to 3 weeks.
b. Amodiaquine	-	-	Total dose 1400-2000 mg spread over 3-5 days .	
5. **8-AMINO QUINOLINES**				
a. Primaquine	1920	1952	15 mg daily for 14 days-*Pv*	10 hrs
b. Pamaquine*	1924	1952	45 mg a single dose-*Pf*	-
c. Quinocide*	1952	1952	-	-

6. **SULFONAMIDES**				
a. Sulfadiazine*	1930	1940s	250 mg three times a day for 5-6 days	-
b. Sulfadimethoxine **	-	-	-	
c. Sulfamethoxy pyridazine - Sulfalene**	1950s	1950s	250 mg daily single dose for 5-6 days	100-120 hrs.
d. Sulfadoxine**	-	-	-	65 hrs
7. **SULFONAMIDE + PYRIMETHAMINE**				
a. Sulfalene 500 mg & Pyrimethamine 25 mg one tablet	1970s	1970s	1500 mg Sulfalene 75 mg Pyrimethamine (Single dose)	-
b. Sulfadoxine 500 mg & Pyrimethamine 25 mg - one Tablet	1960s	1960s	1500 mg Sulfadoxine 75 mg Pyrimethamine (Single dose)	-
8. **ANTIBIOTICS**				
a. Tetracycline	1950s	1952	250 mg to 500 mg 4 times for 10 days	6 to 9 hrs
b. Minocycline*	1960s	1960s	100 mg 4 times daily	-
c. Clindamycin*	1960s	1960s	150 mg 4 times daily	
d. Doxycycline$	-	-	100 mg once or twice daily for 7 days.	
9. **MEFLOQUINE**				
(4-Quinoline methanols)	1970s	1970s	750 mg single dose	
10. **QINGHAOSU**	168 B.C.	1972		
Artemisinin	-	-	500 mg/day X 5 days (8 mg/kg body wt)	
Artemether	-	-	160 mg I.M. 80 mg OD Total 640 mg (3.2 mg & 1.6 mg/kg body wt.)	4-11 hrs
Artesunate	-	-	120 mg I.V. 60 mg 12 hourly Total 640 mg (2 mg & 1 mg/kg body wt.)	4 to 8 hrs.
11. **HALOFANTRINE**	-	1988	500 mg 6 hourly X 3 days (8 mg/kg body wt. 6 hourly)	1 to 3 days

* Drug not used generally or not used alone for treatment

** Recommended for use only in combination with Pyrimethamine

$ Used in combination with Quinine

SECTION - 2
PRINCIPLES FOR EVOLVING NATIONAL ANTIMALARIA DRUG POLICY

DEFINITION

In 1988, WHO defined the national antimalaria drug policy as **'a set of recommendations and regulations concerning antimalarial drugs and their utilisation in the country'.** The National Antimalaria Drug Policy should be a part of National Drug Policy and also contain a set of guidelines for use of antimalarials by medical profession and National Malaria Control Programme.

NEED FOR DRUG POLICY

It is a known fact that Chloroquine is a versatile antimalarial drug. Under normal circumstances, it acts against all stages of schizogony and immature gametocytes of malaria parasites. When introduced for the first time in an area, it produces clinical as well as parasitological remission in 98 to 99% cases of malaria infection within 72 to 120 hours. With rational use of Chloroquine, chances of selecting a resistant strain are very meagre. If Chloroquine therapy is coupled with effective transmission control operations, the resistance may not appear for a couple of decades or even more. On the other hand indiscriminate use, irrational drug schedule, chemotherapeutically ineffective dosage, poor drug compliance during chemoprophylaxis tend to select out resistant strains of *P.falciparum* within a short period of time. There are several hypotheses regarding appearance of drug resistance in malaria parasites. Most plausible theory is that like populations of other living organisms, *P.falciparum* population also has a very small proportion of viable mutants. Some of these mutants have an alternate metabolic pathway to withstand the action of antimalarial used for treatment of a malaria case, as a result sensitive parasites are killed and the viable mutants with alternate metabolic path way survive and multiply, thereby *P.falciparum* strains resistant to Chloroquine or other antimalarials are selected. The resistant strain is more likely to be selected in insurgent areas or in transmigrant population groups where, on account of unsettled conditions, there is indiscriminate use of the antimalarials like Chloroquine, long acting Sulfa and Pyrimethamine combination, Mefloquine, etc. All these drugs have one common feature, i.e. most of them have long half life. At the tail end of the blood concentration, the drug level is chemotherapeutically ineffective. During this period, the mutants survive and multiply. This population of resistant strain is then locally transmitted and gets established. The resistant strains are usually not selected against the drugs with short half life because of frequent administration of dosage to attain clinical and parasitological cure and thereby the chemotherapeutically ineffective blood levels are for a very short period of time only and next dose of the drug again elevates the blood concentration to therapeutically effective levels.

It is seen that *P.falciparum* strains show resistance to Chloroquine while the tolerance is exhibited by *P.vivax* to some of the antimalarials. As such, there is an urgent need to have National Antimalaria Drug Policy to rationalise the approach to malaria chemotherapy. This aspect gains paramount importance in the light of the fact that in some of the South East Asian, African and South American countries, *P.falciparum* has shown resistance to second line of antimalarials within a very short period of time after their introduction for general use in the country. In India, the situation is not so urgent. The degree of resistance in *P.falciparum* resistant strains to the second line of antimalarial drugs is very low and the foci are limited.

SELECTION OF ANTIMALARIAL DRUG - OPTIONS AVAILABLE

As already mentioned, the endemic countries should recognise the fact that resistance to the antimalarial drugs will ultimately develop when they are used extensively for treatment of uncomplicated *P.falciparum* malaria. When the first line of drug, usually Chloroquine becomes increasingly ineffective, it should be changed before

there is a significant rise in incidence of malaria with high morbidity and mortality. The policy requires consideration of not only drug resistance and efficacy of antimalarials but also the target population, immunity levels, compliance with treatment schedules, cost of the new drug and its availability, etc.

The WHO document on Antimalaria Drug Policy (March, 1994) has given two case studies on antimalaria drug policies of Malawi and Thailand.

In Malawi, there were reports of drug failure in *P.falciparum* cases with Chloroquine at a dose of 10 mg per kg body wt. It was confirmed that parasitological clearance by Day 7 was not obtained in 84 per cent of cases. When the dose was increased to 25 mg per kg body wt., it affected clinical cure in 92% of the cases but failed to clear parasites in half of the cases. Malawi Government formulated a malaria treatment policy and recommended Chloroquine as the first line of drug for treatment of malaria cases. For treatment of malaria cases not responding to Chloroquine, antimalarials like Sulfadoxine plus Pyrimethamine or Amodiaquine were reserved as second line of treatment, while Quinine was recommended for treatment of complicated malaria cases. Although R III level of resistance to Chloroquine has risen, there is no resistance to Sulfadoxine and Pyrimethamine as yet - 1993 report. The other determinants for change of drug policy in Malawi were consumer pressure, competitive cost and compliance to drug schedule. A single dose of tasteless Sulfadoxine + Pyrimethamine had facilitated drug compliance by the population in general.

In Thailand resistance to Chloroquine and other antimalarials has developed more quickly. On finding Chloroquine resistant strains of *P.falciparum* the Sulfadoxine + Pyrimethamine was introduced. The adult dose was 1 gm. It replaced Chloroquine as a first line of treatment of *P.falciparum* infection in 1973. It was effective in checking malaria morbidity and mortality over next 7 years. Later on there were reports of drug failure. The dose was increased to 1.5 gms. The efficacy of Sulfadoxine+Pyrimethamine gradually decreased. Quinine and Tetracycline became first line of treatment, later replaced by Fansimef.

The experience on the use of different antimalarials as a first line of treatment to *P.falciparum* cases necessitated differentiation of areas based on the response of *P.falciparum* to different antimalarials, as the response differed widely throughout the country. The introduction of alternative drug after *P.falciparum* exhibits resistance to currently used drugs without measures for transmission control or ensuring proper drug compliance leads to selection of resistant strains more quickly and morbidity and mortality rates increase. The quick emergence of resistance in Thailand to antimalarials successively used as first line of treatment was basically due to indiscriminate and irrational self medication by illegal gem miners on Thai-Kampuchean border where transmission control activities were non-existent.

In India the recent Drug Policy lays down that Chloroquine should be used as a first line of treatment all over the country and even in areas showing R II and R III level of resistance. The drug schedule has been changed in selected pockets showing R II & R III levels of resistance at 25% or above in a minimum of 30 cases studied. Here the second line of drug will be long acting Sulfa and Pyrimethamine combination. Quinine is the drug of choice for treatment of complicated malaria cases. The details of National Drug Policy of India are given in Section-3.

AIMS AND OBJECTIVES

1. The primary aim of the drug policy should be to ensure prompt clinical and parasitological cure in a malaria patient. This primary purpose is encompassed in the basic technical elements of the WHO Global Malaria Control Strategy (WHO 1993). The clinical and parasitological cures are defined as:-

a. Clinical Remission - is clearance of sign and symptoms of malaria within a reasonable period of time in the patient under treatment.

b. Clinical Cure - is remission of sign and symptoms of malaria plus prevention of recrudescence i.e. non-appearance of sign and symptoms within 14 days following the completion of treatment.

c. **Parasitological Cure** - entails elimination of all stages of parasite from the body i.e. liquidation of all stages of schizogony and gametocytes as well as hypnozoites in case of *P.vivax* and *P.ovale*.

2. a. **The first objective** - prompt treatment can be defined as administration of effective antimalarial drug schedule to a patient suffering from malaria on his first contact with peripheral health worker or a medical facility. The prompt treatment should also aim to prevent further serious complications in the patient and ensure prevention of further spread of infection.

b. **The second objective** - is to minimise the selection pressure of the antimalarial drug to prevent emergence of drug resistant strains. Although it is classified as second objective, it is even more important than any other objective because of availability of only a limited number of antimalarial drugs for treatment of malaria cases. The treatment is further restricted on account of the high cost of new antimalarials, their serious side effects, complex and longer dosage regime necessitating careful monitoring of the case.

Actions Required

i. To fulfill the above objective, the medical profession should be given complete orientation in selection, use and dose schedule of antimalarial drugs. The limited knowledge concerning the use of antimalarial drugs and irrational use of dosage results in selection of resistant strains.

ii. It is further necessary to have full control on drug distribution and their availability to the medical profession to avoid indiscriminate use of new antimalarials as well as self administration by the individuals.

iii. It is possible that these restrictions on distribution and availability of specific antimalarials, the rigid control on optimum dosage of antimalarials, for achieving complete clinical and parasitological cure and thereby bringing uniformity of treatment in malaria cases is likely to be resisted by physicians because their option in use of antimalarials for treatment of malaria is restricted by such a policy.

iv. These restrictions are essential and beneficial. In the long run they prevent emergence of resistant strains of parasite. They are all the more necessary as the number of antimalarials available at this juncture is limited.

The components to meet the objectives of National Antimalaria Drug Policy should be:-

a. Selection of suitable antimalarial out of the total number of antimalarials available for treatment of infection with different species of malaria parasites.

b. To lay down the guidelines for use of antimalarials registered in the country for treatment of malaria cases.

c. Promulgation of regulations specifically as regards to second line of drugs, their prescription, availability, fixing the outlets for sale, distribution to the community and utilisation by medical profession.

d. It is necessary to make antimalarials available to the community at an affordable price. Therefore, price regulatory mechanism should be developed by the National Government in respect of antimalarials. If required, the prices may have to be subsidised.

e. As all antimalarials are not manufactured in the country, a long-term policy for their import or manufacture in sufficient quantities to meet the requirement by the National Malaria Control Programme and medical profession should be formulated. This policy should ensure uninterrupted availability of antimalarial drugs suited to meet the country's requirements.

f. It is necessary to lay down the rules for regulating quality of antimalarials.

g. A regulatory mechanism for distribution system should ensure availability of drug on demand across the sale counter or the National Malaria Control Organisation.

h. In the light of emergence of resistant strains of *P.falciparum*, it has become necessary that the National Drug Policy should specify the **second line of treatment** for uncomplicated malaria case(s) when first line of treatment fails.

i. The policy should also lay down guidelines

for treatment of complicated malaria cases i.e. *P.falciparum* cases presenting with serious sign and symptoms.

j. The pregnant women, who are at high risk to malaria, should receive regular and prompt treatment. The Drug Policy should define the procedure to be adopted for treatment of pregnant women and also lay down guidelines for prevention of malaria among them.

k. The Government should enact regulations to define the physicians authorised to prescribe second line of antimalarials and the outlet for such drugs to minimise their misuse.

l. The regulations should be promulgated specifying the health services i.e. Fever Treatment Depot, Village Link Worker, Multipurpose Worker, Primary Health Centre, Dispensary, Peripheral Hospital and Referral Hospital who will give to a malaria patient which category of antimalarial i.e. first or second line of drug. The decision to make particular drug available through specified outlet should be made after considering the diagnostic and therapeutic facilities available at every health facility cited above.

PRICE REGULATIONS

The National Government should ensure that the prices of essential antimalarials necessary for treatment of *Plasmodium* infection are so regulated that they are affordable by the public. If necessary the industry should be subsidised, so as to keep the price of antimalarials within the reach of common man. If the price of antimalarials is exorbitant, a large portion of the community will not be able to afford the treatment or they may take only partial treatment. In these circumstances, chances of selecting resistant strains of the parasite to the drugs increase. Therefore, the cost of the antimalarial to the consumer should be so regulated that even a common man can afford it. Cost structure is not suggested because the cost of antimalarials in India or other countries will fluctuate with inflationary process.

REGULATIONS ON SUPPLIES AND DISTRIBUTION

The misuse of antimalarials is likely to select a resistant strain within a short time. For example indiscriminate use of new drugs such as Mefloquine will precipitate resistance within a period of 3 to 4 years. There should be specific regulations and laws concerning import, manufacture, quality control and distribution by fixing outlets and restrictions on sale of antimalarials through proper authorisation/prescription.

The National Drug Policy will differentiate in procurement and supply of different antimalarials.

i. Drugs for first line of treatment of malaria infection should be made widely available through all health care outlets and even through the market sources. This category should include drugs like Chloroquine, Quinine, Primaquine, Tetracycline, Doxycycline, etc.

ii. The second line of drugs should be reserved for treatment of drug resistant strains of malaria parasites. Regulations for use of these drugs should be more stringent. The drug should be available through specific outlets, at a specified health facility and on a prescription of a qualified medical practitioner. Drugs like long acting Sulfa + Pyrimethamine, Mefloquine, Artemisinin and its derivatives fall in this category.

iii. An expert committee should decide whether in the light of the status of *P.falciparum* resistance to Chloroquine, is it necessary to introduce any of the above drugs and if so, in which part of the country and what should be the regulatory mechanism for use of the drug. Under the Indian conditions, taking into consideration the status of *P.falciparum* resistance to Chloroquine in the country, its distribution and presence of R II and R III level of resistance, the National Drug Policy was reviewed by an Expert Committee in the year 1995.

CHOICE OF ANTIMALARIAL COMPOUNDS FOR MALARIA CHEMOTHERAPY

A. Treatment of Uncomplicated Malaria

For treatment of **fever or clinically diagnosed malaria case**

i. **First Line of Drugs**

In a **new area or an area with sensitive strains of *P.falciparum*:-**

Treatment Category	**Antimalarial of Choice**	**Type of Cure**
-Presumptive treatment (before microscopic confirmation)	Chloroquine - Single dose	Clinical and parasitological remission achieved in malaria infections with all species
-Radical treatment (after microscopic confirmation)		
a. *P.falciparum*	Chloroquine - Single dose + Primaquine - Single dose	Complete parasitological cure obtained.
b. *P.vivax*, *P.malariae* and *P.ovale*	Chloroquine - Single dose + Primaquine for 5 or 14 days	Complete parasitological cure achieved, gametocytes and hypnozoites are also liquidated.

ii. Second Line of Drugs

In **area with *P.falciparum* strains resistant to Chloroquine:-**

-Presumptive treatment (before microscopic confirmation)		
a. In areas with 50% or more *P.vivax* infection and *P.falciparum*. R II/R III % levels are low. (below 25%)	Chloroquine - Single dose or 3 doses	Clinical cure in most cases ; Parasitological remission in *P.vivax* observed

The criteria for high or low percentage of R II & R III to be decided by National Government - Generally if R II and R III level of resistance combined together against an antimalarial is 25% or more, a change to alternative drug is recommended.

b. In areas with *P.falciparum* predominance & R II/ R III percentage levels are high (25% or above)	Chloroquine - Single dose + Long acting Sulfa and Pyrimethamine combination	Clinical and parasitological remission achieved in malaria infections with all species.
- Radical treatment (after microscopic confirmation)		
a. *P.falciparum*	Long acting Sulfa and Pyrimethamine combination - Single dose +Primaquine - Single dose.	Complete parasitological cure achieved.
b. *P.vivax*, *P.malariae* and *P.ovale*	Same as first line of drugs i.e. Chloroquine - Single dose + Primaquine for 5 or 14 days	Complete parasitological cure achieved.

iii. Third Line of Drugs

In **area where** *P.falciparum* **is resistant to both Sulfa and Pyrimethamine combination and Chloroquine:-**

- Presumptive treatment (before microscopic confirmation	Mefloquine - Single dose	Clinical and parasitological remission achieved in malaria infections with all species.

If Mefloquine is not available, Amodiaquine in three doses can be used for a few years. Mefloquine should be used cautiously because of the danger of early selection of resistant strains of *P.falciparum* .

- Radical treatment (after microscopic confirmation)		
a. *P.falciparum*	Mefloquine - Single dose or Quinine for 7 days + Tetracycline for 10 days + Primaquine - Single dose after completing Quinine therapy	Clinical and parasitological cure obtained.
b. *P.vivax, P.malariae* and *P.ovale*	Same as first line of drugs i.e. Chloroquine - Single dose + Primaquine for 5 or 14 days	Complete parasitological cure achieved.

B. Treatment of Complicated Malaria with *P. falciparum* Infection

Start antimalarial on clinical diagnosis, without waiting for microscopic results. Examine serial blood slides at 6 hourly interval for monitoring response.

- Primary treatment	Quinine I.V. till patient regains consciousness, continue oral Quinine - total duration 7 days or I.V. Artemisinin e.g. Artesunate or Artemether	Achieves clinical and parasitological remission
- Radical treatment (after microscopic confirmation)	Oral Primaquine - Single dose	Complete parasitological cure obtained

PACKAGING OF ANTIMALARIALS

In India, normally the antimalarials are strip packed for sale across the counter. The bulk packing in tins of 1,000 tablets each is done for supply to the hospitals and National Malaria Eradication Programme (NMEP). In the hospitals, the issue of antimalarials from the bulk supply is usually well regulated and consumed within the expiry date. Under NMEP, the supplies are procured through Medical Store Depots by Logistics incharge at the national level. The State Malariologists on receipt of requirement at the State Headquarters, in turn allot antimalarials to the District Malaria Officers. From there, these antimalarials are supplied to the Primary Health Centres. Distribution of antimalarials from the stores of the PHC to the Multipurpose Workers is more or less satisfactory.

However, it has been observed that the Fever Treatment Depots and the Drug Distribution Centres are given tablets in packed tins of 1,000 tablets, although instructions are to give 200 tablets at a time and replenish them whenever required. The disadvantage of the dumping of a large number of tablets at these health posts is that when a DDC or FTD becomes defunct, these tablets are not utilised and are lost to the programme. It may be advisable to procure supplies in smaller packing of suitable size for use by the peripheral voluntary agencies. Alternatively they can be repacked in smaller containers preferably in 200 tab. containers by the State or District authorities whichever is logistically convenient.

MARKING ON TABLETS

The tablets packed in strips do not require separate markings but the tablets should be scored as some of them may have to be broken for administration of lower doses to the children.

The bulk purchases made by the NMEP should be marked suitably to indicate that the tablets have been supplied to the NMEP. They should also be scored for breaking them into smaller pieces to facilitate administration of lower doses to the children.

QUALITY CONTROL

It is absolutely necessary to maintain the quality of antimalarials. For example - if base contents vary in each tablet by ± 10%, the dose of 600 mg Chloroquine will be reduced to 540 mg per dose or increased to 660 mg In case of infants and children, because of low chemotherapeutic index of Chloroquine, serious complications may arise if the contents are not standardised. It is suggested that in all antimalarial tablets used for treatment of malaria the base content should be within ± 2%.

Every batch of the drug should be tested for quality control by the medical store depots. After the supply is effected to the central organisation, they should independently carry out the quality control of the drug. Similarly at State level, quality control should be repeated before the drug is distributed to the periphery.

In case the drug failure is observed by the peripheral medical officer, the first task of the medical officer should be to send drug samples taken out of the container from which the treatment was given, for quality confirmation to the laboratory designated by the State Government or as per the guidelines issued by the appropriate authorities. The State Government can select reputed laboratories within the State for this purpose and make a standing arrangement with them to test the drug samples sent from the periphery by authorised medical officers on priority. Suitable arrangements for payment of fees for testing the drug should be made so that the sample testing is not delayed for want of finances. The test report should be made available within a short time but not later than 30 days.

SHELF LIFE

The bulk procurement of antimalarial should be distributed in such a manner that it can be consumed at the peripheral level before the date of expiry. The Procurement Officer should consider the time taken from the date of procurement, to allotment to the State, likely delay in distribution to the districts and later to the periphery and

thereafter its ultimate administration to a malaria case. This period is usually 3 to 9 months.

STORAGE INSTRUCTIONS

The antimalarials should be stored in air tight containers. Exposure to humidity and heat should be avoided especially in case of sugar coated tablets. The strip packed tablets do not require elaborate precautions for storage. However, the plastic coated strips are usually nibbled by rats and cockroaches. Therefore, the strip should be stored in places not infested with rats/cockroaches.

ESTIMATES OF REQUIREMENT

Requirement of Chloroquine

In NMEP, Chloroquine is the drug of choice. It is used all over the country except in a few selected areas with approximately 25 million population where second line of drugs are administered.

The requirement of Chloroquine is calculated as follows:-

$$\text{Total Pop. x } \frac{\text{Local Fever Rates}}{100} \text{ x } 3 = \text{Total number of tablets required}$$

At the national level, taking 900 millions as the population of the country in 1995, and average fever rate as 15% for the country as a whole, the requirement of the antimalarials will be :

$$\frac{900 \text{ x } 15}{100} \text{ x } 3 = 405 \text{ million tablets.}$$

This quantity can be suitably distributed to the States on the basis of their own estimates of fever rates. Out of this quantity sufficient number of antimalarials can be given to FTDs because the 15% fever cases are screened combined together by FTDs, DDCs and peripheral health worker and medical institutions.

Requirement of Quinine

As already mentioned, out of total *P.falciparum* cases, only 0.5% to 2% go into serious complications requiring treatment with Quinine injection. Therefore, at the national level, the requirement can be calculated as under:-

$$\frac{\text{Total } P.falciparum \text{ cases x 2 x } 9^{*}}{100} = \text{Ampules of Quinine injection required}$$

* nine ampules are sufficient for a three day i.v. administration. It is expected that during this period patient will come out of coma and will be able to take oral antimalarial. If the response is delayed and patient remains in comatose condition after three days, the clinical condition is carefully evaluated as the delayed response may be due to some other pathology.

After the complicated case of *P.falciparum* regains consciousness or is able to take oral tablets, the Quinine therapy schedule of seven days should be completed with oral administration. Requirement for tablets is calculated as under:-

$$\frac{\text{Total } P.falciparum \text{ cases x 2 x 18}}{100} = \text{Total number of Quinine tablets required}$$

The distribution of *P.falciparum* is not uniform in the country. Each State should calculate the requirement on the basis of the *P.falciparum* cases recorded in the State and the indent should be placed to the Central Organisation well in time i.e. one year earlier to facilitate procurement and supply.

Requirement of 8 - aminoquinoline

8-aminoquinoline is procured in tablets of 2.5 mg and 7.5 mg. The estimates should be based on the number of positive cases detected in the community taking into consideration, both *P.vivax* and *P.falciparum* cases. The calculation is as under:-

$$\text{Total number of positive cases} \text{ x } 8 = \text{Total number of 8-A Q tablets required.}$$

The total procurement should be divided equally between 2.5 mg and 7.5 mg tablets.

Some of the formulations of 8 - aminoquinoline are sugar or lacquer coated. These tablets require special storage facilities.

Requirement of Long Acting Sulfa + Pyrimethamine

The requirement of long acting Sulfa +

Pyrimethamine should be based on the population where second line of treatment is to be administered to *P.falciparum* cases under the National Drug Policy. Estimates are made by taking into account:-

Number of *P.falciparum* of cases recorded in the locality	x 3 =	Total number of tablets required

Rough Estimates of Buffer Stock

Lastly 20 to 25% of annual requirement of all antimalarial tablets or injectable should be kept as a buffer stock to meet the requirement of pipeline and emergent situations.

The buffer stock of the previous year should be utilised in the beginning of the year through suitable distribution. Current buffer stock should be built up from fresh supplies.

Reserve Stock for Epidemic Control

Apart from these minimum requirements, there should be a provision for drugs in the pipeline as well as buffer stock to meet the emergent requirement of the epidemic areas. It must be kept in mind that the procurement process i.e. making estimates of requirements, getting financial sanctions, placing procurement orders with the manufacturers, flow of supplies being dependent on the firm's manufacturing capacity and ready stocks held by them, usually delays availability of drugs. Under these circumstances, it is not possible to make available the drugs by bulk purchase or even local purchase for use in epidemic area at a short notice.

The drugs should be made available immediately within three days to the epidemic areas to prevent high morbidity and mortality. Therefore, it is necessary that the buffer stock should be held at district level for use in case of epidemics/focal outbreaks.

SECTION-3
NATIONAL ANTIMALARIA DRUG POLICY - INDIA 1995

Since inception of surveillance under NMEP (1961), a set pattern of drug schedule was followed and the first National Antimalaria Drug Policy was formulated in 1982 to combat the increasing level of resistance to Chloroquine detected in *Plasmodium falciparum**. Thereafter the drug policy was reviewed periodically based on the drug sensitivity studies. In the wake of recent large scale epidemics of malaria in different parts of the country accompanied with high mortality, the question of availability of antimalarials and treatment policy of malaria cases was under debate in many quarters including the medical profession.

To look into these aspects of malaria chemotherapy, a Committee of medical experts from different specialities - clinical, pharmacology, malariology, etc. was constituted by the Director General of Health Services under his chairmanship.

The Committee deliberated on various aspects of malaria chemotherapy such as (i) availability of antimalarials at national and international levels, (ii) pharmaco-dynamics of antimalarials, (iii) resistance of different species of malaria parasite especially *P.falciparum* to antimalarials, the distribution and magnitude of the problem in the country and (iv) response of the Indian strains of *P.falciparum* to different antimalarials.

After extensive discussions on the information made available by the Directorate of National Malaria Eradication Programme, Malaria Research Centre (ICMR) and review of national and international experiences along with the opinion of clinicians and pharmacologists, the Committee has observed that:-

Presently the following antimalarials are available but their use is determined on the basis of the action of each antimalarial against a particular species of *Plasmodium* and its stages, rapidity of action, toxicity, etc.

i. **Schizonticidal drugs** for clinical and parasitological cure

- Chloroquine, Amodiaquine, Quinine, Quinidine, Pyrimethamine, Trimethoprim, Proguanil, Sulfonamides in combination with Pyrimethamine, Mefloquine, Halofantrine, Artemisinin.

ii. **Gametocytocidal and anti-relapse drugs**

- 8-aminoquinoline group-Primaquine, the only compound having action on gametocytes and hypnozoites.

As regards action of different antimalarials on various stages of malaria parasite of different species some of the salient points considered by the Committee are :-

i. a. Chloroquine is a very effective and rapidly acting schizonticidal drug. The drug is least toxic with a few adverse effects. Resistance to this drug has been detected in *P.falciparum* in some parts of the country.

b. Amodiaquine has similar action as Chloroquine but it is more toxic if used over long period for chemoprophylaxis. Its advantage over Chloroquine in Chloroquine resistant cases is short lived due to cross-resistance and therefore it is not recommended for use.

ii. Sulfa and other antifolate drugs when combined potentiate each other's antimalarial action. They are slowly absorbed and their action on parasite is much slower than Chloroquine. These are recommended for use against Chloroquine resistant *P.falciparum* only.

iii. Quinine is an effective schizonticidal drug with a short half life and is used extensively - orally and in injectable form. Resistance to Quinine in India has not been reported and therefore it should be reserved for complicated cases.

* **Note:** The current status of drug resistance of malaria parasite to antimalarials is given in Chapter-3 - Section-4 on Monitoring of Drug Resistance in *P.falciparum* infection in India.

iv. **Mefloquine:** This drug is not presently marketed in the country but is available in the international market. It is a schizonticidal drug against all species of parasite but has no action on gametocytes and hypnozoites. It is very slowly absorbed, action on parasite is slower than any other antimalarial available. Its half life is very long. Therefore, resistant strains are selected more quickly than with any other antimalarial. It has got severe toxic effects especially neuro-toxicity and should be carefully used.

v. **Halofantrine:** Available internationally and not marketed in the country. The drug has got similar action as Mefloquine. The strains resistant to Mefloquine have shown cross-resistance to Halofantrine and vice-versa. The serious disadvantage is that absorption of Halofantrine is very erratic and even with therapeutic doses, serious complications are likely to arise in spite of careful medical supervision.

vi. **Artemisinin group of drugs:** These drugs have action as schizonticidal drugs. Their action is quicker than other antimalarials available so far. Intravenous administration of these compounds is much safer than the intravenous administration of Quinine. They are comparatively less toxic than other antimalarials parenterally administered. Oral preparations are also available. The drug is not marketed in India.

The Committee has reviewed the profile of *P.falciparum* resistance to Chloroquine in the country and observed that resistance is widely scattered but in most of the pockets magnitude and degree of resistance is not very high.

After detailed deliberations and considering the present scenario of parasite profile in the country and their resistance to available antimalarials, the Committee has observed that:-

a. Chloroquine is still the drug of choice for treatment of all malaria cases in Chloroquine sensitive areas of the country irrespective of the species involved.

b. 600 mg of Chloroquine-adult dose (10 mg per kg body weight) is adequate to treat *P.vivax* and *P.malariae* infections provided the drug is taken as a single dose, ingested and not vomited.

c. For treatment of *P.falciparum*, although in most parts of the country 600 mg - adult dose (10 mg per kg body weight) is adequate, but in the areas declared resistant or where *P.falciparum* incidence is very high and in other high risk areas, a dose of 1500 mg in three divided doses of 600 mg single dose each on first and second day and 300 mg on the third day (25 mg per kg body weight over three days in divided doses) will cure most of the cases of *P.falciparum*. However, some cases may not respond, which can be presumed to be infected with Chloroquine resistant strain of *P.falciparum*. In these cases, Metakelfin or Fansidar can be given (three tablets as adult dose). As yet, there is no evidence of resistance to these drugs in the country.

The Committee recommends that:-

i. The first line of treatment is **Chloroquine** and the second line is **Sulfalene / Sulfadoxine Pyrimethamine combination**. In cases resistant to these two drugs and in severe and complicated malaria cases **Quinine** will be used.

ii. All suspected malaria cases should be presumptively administered 25 mg/kg body weight of Chloroquine base over three days with a single dose of Primaquine 0.75 mg/kg body wt. This drug regime is to be followed up to the subcentre level throughout the country but at present to be **limited to the high risk areas.** In the **low risk areas** and Drug Distribution Centres (DDCs) and Fever Treatment Depots (FTDs) throughout India, presumptive treatment with 10 mg/kg body weight Chloroquine single dose will continue.

iii. The dose of Primaquine for *P.vivax* cases is 0.25 mg/kg body wt. daily for 5 days to prevent relapse and for *P.falciparum* 0.75 mg/kg body wt single dose for gametocytocidal action. Where presumptive treatment with Primaquine has been given in sensitive areas, a second dose with it will not be required.

iv. Amodiaquine has no advantage over Chloroquine in Chloroquine resistant areas and considering the toxicity associated with its prolonged use, Amodiaquine may be withdrawn from the programme and also from the private sector.

PRESUMPTIVE TREATMENT IN HIGH RISK AREAS

Chloroquine base	Day 1	10 mg/kg b.w.	(600 mg adult)
Primaquine		0.75 mg/kg b.w.	(45 mg adult)
Chloroquine base	Day 2	10 mg/kg b.w.	(600 mg adult)
Chloroquine base	Day 3	5 mg/kg b.w.	(300 mg adult)

RADICAL TREATMENT AFTER MICROSCOPIC CONFIRMATION OF SPECIES

IN CHLOROQUINE SENSITIVE *P.FALCIPARUM* AREAS

P.vivax - Primaquine 0.25 mg/kg b.w. daily for five days

P.falciparum - No further treatment required.

IN CHLOROQUINE RESISTANT *P.FALCIPARUM* AREAS

P.falciparum - Single dose of 25 mg/kg b.w. Sulfalene/Sulfadoxine and 1.25 mg/kg b.w. Pyrimethamine (3 tab. Adult) with Primaquine 0.75 mg./kg b.w.

PRESUMPTIVE TREATMENT IN LOW RISK AREAS

Chloroquine base single dose 10 mg/kg b.w. (600 mg adult)

RADICAL TREATMENT AFTER MICROSCOPIC CONFIRMATION OF SPECIES

P.vivax - Chloroquine 10 mg/kg b.w. single dose and Primaquine 0.25 mg/kg b.w. daily for five days.

P.falciparum - Chloroquine 10 mg/kg b.w. plus Primaquine 0.75 mg/kg b.w. single dose.

v. In severe and complicated malaria cases with *P.falciparum* infection (microscopically confirmed), intravenous Quinine is the drug of choice. Intramuscular or intravenous Chloroquine is not well tolerated by children or pregnant women and therefore may be used very cautiously and only when Quinine is not available.

vi. Although *P.falciparum* cases can be cured with the above drugs provided the treatment is not delayed and supportive therapy is started in time, the Committee is of the considered view that in the light of the demand made by the medical fraternity, **Mefloquine** can be used for treatment of *P.falciparum* cases resistant to Chloroquine only and not for treatment of *P.vivax* cases. Therefore, it is recommended that the Drug Controller of India may stipulate strict conditions for import, sale and use of Mefloquine through a depot system where:-

a. It should be mandatory that the drug is issued only on the prescription by a qualified registered medical specialist.

b. The prescription should be accompanied with a laboratory report issued by a qualified parasitologist indicating that there are ***P. falciparum* rings in the peripheral blood and not gametocytes alone.**

vii. Considering the erratic absorption of **Halofantrine,** its toxic effect even with therapeutic doses and difficulty in management of cases with toxic manifestations, the Committee is of the opinion that this drug should not be introduced in the country. Another further corroborative factor is that *P. falciparum* strains resistant to Mefloquine show cross-resistance to Halofantrine and vice-versa.

viii. The Committee has observed that sufficient quantity of **Quinine injectable** is not available in the country to treat the estimated serious cases likely to occur in future. Therefore, the Committee is of the view that Artemisinin and

its derivatives should be introduced in the management of severe and complicated *P.falciparum* infection in area of resistant foci. The drugs should be made available in injectable forms only to prevent misuse but again careful monitoring of the distribution system is imperative.

ix. **Quinine** will be reserved for use in severe and complicated malaria but will be used in cases not responding to Chloroquine and Sulfa-Pyrimethamine combination. In case of non-availability of Quinine, **Quinidine** may be used under strict cardiac monitoring.

x. **Primaquine** is the only drug available which acts against the gametocytes of *P.falciparum* as well as hypnozoites of *P. vivax*. The Committee feels that this drug should be made available freely in the market on prescription of a physician for radical treatment.

xi. Under the National anti-malaria programme, it is recommended that Primaquine may be administered to *P.vivax* cases for five days @ 0.25 mg/kg b.w. daily to prevent relapse. A 14 days radical treatment is not advocated because of toxicity, operational difficulty and also since it has very little advantage over five days radical treatment in an endemic area. However, those physicians who want to administer 14 days radical treatment should do so under close supervision, carefully monitor for the complications which are sometimes very serious with fair risk of mortality.

Authors' note: Before commencing of 14 days treatment with Primaquine, if facilities are available, G6PD estimation should be done or weekly dose of 45 mg may be given for 8-10 weeks. However, in endemic areas antirelapse treatment is not mandatory.

xii. **Chemoprophylaxis:** The Committee is of the considered view that population living in non-endemic areas do not require chemoprophylaxis unless they temporarily migrate to endemic areas. The population living in endemic areas except pregnant women should not be put on long-term prophylaxis on account of chronic toxic effects of the drugs.

Pregnant women living in endemic and hyper-endemic areas are highly vulnerable to complications of *P.falciparum* because of suppressed immunity. Chemoprophylaxis is therefore recommended and should commence at the end of first trimester of pregnancy.

Travellers including service personnel who temporarily go on duty to meso-endemic or hyper-endemic areas are at high risk and therefore must be on chemoprophylaxis starting before the transmission period and terminating four weeks after the transmission period is over.

The temporary labour population migrating from other parts of the country to meso-endemic and hyper-endemic areas are also at high risk and should be under chemoprophylaxis. Considering that there is poor compliance from this group, the Committee suggests that after initial screening and radical treatment at the point of entry, it is better to put them under weekly case detection and treatment on technical and operational grounds.

The Committee then has considered the suitability of different antimalarials available for chemoprophylaxis and recommends that Chloroquine is the drug of choice for chemoprophylaxis. After a loading dose of 10 mg/kg body wt. it should be followed by a weekly dose of 5 mg/kg body wt. This is to continue till one month after delivery in case of pregnancy or stay in an endemic area. **Chemoprophylaxis with Chloroquine is not recommended beyond three years because of its cumulative toxicity.** In Chloroquine resistant areas chemoprophylaxis is recommended with Chloroquine 5 mg/kg body wt. weekly and proguanil 100 mg daily.

Amodiaquine and Sulfa+Pyrimethamine combination is not recommended for prophylaxis due to their toxic effects on prolonged use.

Mefloquine and Halofantrine are not considered suitable for chemoprophylaxis due to their toxic effects and also since *P.falciparum* resistance problem is not very serious in the country.

Quinine and Artemisinin group of drugs are not suitable on account of very short half life and consequently require repeated administration of drugs.

Authors' remarks : Quinine and Artemisinin group of drugs should never be used for chemoprophylaxis since they are valuable drugs to be reserved for use in complicated malaria cases.

xiii. The Committee has deliberated on the use of Ayurvedic and Homeopathic preparations for treatment of malaria. In the Ayurvedic system, Ayush-64 and other similar combinations have been found to be effective against the human *Plasmodium*. However, their treatment regimen is prolonged and has no advantage over Chloroquine/ Sulfa Pyrimethamine combination. Also several Homeopathic drugs are reported to be effective against malaria but need to be scientifically investigated. The Committee strongly recommends that modern chemotherapeutic antimalarials are never to be used in combination with Ayurvedic or Homeopathic drugs because their compatibility with such drugs has not been investigated so far.

xiv. Monitoring of drug resistance, clinically and parasitologically, should also be conducted by the State Governments and the existing *P.falciparum* monitoring teams of NMEP would be responsible for independent monitoring in selected areas. Monitoring staff would be trained by NMEP/ MRC.

xv. Research institutions and Medical colleges should be involved in the development in malaria diagnostics, screening and testing of newer drugs, estimation of parasite sensitivity, etc. so that the National programme is updated and new technologies can be incorporated in the control strategy.

xvi. To facilitate easy availability and to overcome the problem of antimalarial shortage, it is recommended that the Government of India should develop and promote drug availability in remote areas through the private sector. The State governments should also establish a system to monitor availability of drugs in the periphery.

xvii. Quality control of drugs should be organized and strictly implemented to ensure proper distribution of standard drugs. The State health authorities will be requested by NMEP to carry out sample checks on drugs supplied through State Drug Controller.

xviii. Government of India should initiate steps to encourage indigenous production of Cinchona and *Artemesia annua*. An interministerial group may be set up to suggest measures for plantation in the public as well as private sector.

xix. Health education on the prevention and treatment of malaria should be a part NMEP activities. Active involvement of CHEB should also be ensured. It is essential that wide publicity be given to the revised antimalaria drug policy and to educate the medical and paramedical professionals in the private and public sectors through Indian Medical Association.

xx. All antimalarial drug packaging should carry full information in English, Hindi and regional languages on the dosage, side effects, antidotes, date of manufacture and expiry and other information such as on Chloroquine package 'for complete cure Primaquine therapy is necessary except in infants and pregnant women' for safe and effective therapy.

xxi. The medical practitioners should follow established guidelines but in case of non-response they are at liberty to administer other antimalarials and in combination with antibiotics as considered best.

xxii. Malaria drug policy should be reviewed at least every two years. This is imperative in the rapidly changing epidemiology of malaria, drug resistance in *P.falciparum* and perhaps in *P.vivax*, new antimalarials and availability of more information on existing drugs.

INSTRUCTIONS ISSUED BY DIRECTORATE OF NMEP-INDIA TO PERIPHERAL WORKERS ON USE OF ANTIMALARIALS

Presumptive Treatment

The presumptive treatment is given to all fever cases or cases with history of fever during past 15 days, immediately after the blood smear is collected.

It is to be given to all persons whatever be the age or sex. Even pregnant women in any month of pregnancy or during postpartum period

should receive presumptive treatment. The presumptive treatment is also to be administered to fever cases where the blood smears are not collected as in the case of DDCs, etc.

All FTD/DDC holders, Voluntary Link Workers, MPWs (Male/Female), Health Supervisors (Male/ Female), Laboratory Technicians and PCD will give presumptive treatment.

a. **Presumptive treatment in low risk areas** comprises of a single dose of Chloroquine phosphate @ 10 mg/kg body wt.

Adult Dose

- A Single dose of Chloroquine Phosphate - 600 mg (4 Tablets)

- This is administered by all agencies

Table-3.4: The Age-wise Dosage of Chloroquinefor presumptive treatment @ 10 mg/kg body weight

Age in years	mg base	No. of Tablets
<-1	75	1/2
1-4	150	1
5-8	300	2
9-14	450	3
15 & Above	600	4

b. i. Presumptive treatment in high risk areas up to the Sub-centre level is as follows:-

25 mg/kg body wt. of Chloroquine base over three days (10 mg/kg body wt each on first and second day and 5 mg/kg body wt on third day) along with a single dose of Primaquine 0.75 mg per kg body wt. on the first day. **This drug regimen is to be followed up to the Subcentre level in all high risk areas of the country identified as per criteria laid down by the Expert Committee - 1995.**

Table-3.5: The Age-wise Dosage

Age in years	First Day		Second Day	Third day
	Chloro-quine mg base	Prima-quine mg base	Chloro-quine mg base	Chloroquine mg base
< - 1	75	nil	75	37.5
1 - 4	150	7.5	150	75.0
5 - 8	300	15.0	300	150.0
9 -14	450	30.0	450	225.0
15 & above	600	45.0	600	300.0

Note: Pregnant women and infants are not to be given Primaquine

b. ii. Presumptive treatment in high risk areas by DDCs, FTDs and VLWs:-

The FTD and DDC holders as well as Voluntary Link Workers will administer 10 mg/kg body wt. of Chloroquine base in a single dose without Primaquine as is followed in the low risk areas.

c. **The presumptive treatment in areas with** *P.falciparum* **resistant strain** where Drug Policy of NMEP has been modified - 1995, will be as under at different levels:-

TABLE-3.6: PRESUMPTIVE TREATMENT IN *P.falciparum* RESISTANT AREAS

ADULT DOSE

S.No.	Agency	Presumptive Treatment	
		Drug	**Dose**
1.	DDCs, FTDs & VLWs	Chloroquine	600 mg as a single dose
2.	ACD MPW (Male & Female) Health Supervisor (M & F)	Chloroquine + Primaquine	1500 mg in 3 divided daily doses i.e. 600 mg each on 1st and 2nd day & 300 mg on 3rd day **with** a single dose 45 mg Primaquine on 1st day
3.	PCD* PHC Medical Officer OPD	Sulfalene/ Sulfadoxine + Pyrimethamine	1500 mg + 75 mg as a single dose

***In case microscopic diagnosis is not available immediately at a PCD, the presumptive treatment should be Chloroquine plus Sulfa combination because Sulfa combination has very little action on *P.vivax*.** However, the person administering the presumptive treatment will ensure that Sulfa combination tablets are swallowed in his presence and he will advise the case to consume Chloroquine tablets soon thereafter.

Considering that Amodiaquine has no advantage over Chloroquine in treatment of resistant strain of *P.falciparum* and also the toxicity associated with this drug on prolonged administration, Amodiaquine has been withdrawn from NMEP.

Radical Treatment

All microscopically positive cases of malaria are to be given radical treatment with Primaquine for its gametocytocidal and anti-relapse properties. This ensures a complete cure from malaria in the positive case and makes the patient non-infective to mosquitoes. **However in high risk areas, the fever cases given three days presumptive treatment i.e 1500 mg Chloroquine and 45 mg Primaquine (adult dose), and later found positive for *P.falciparum* need not be given radical treatment.**

a. Radical Treatment for *P.vivax*, *P.malariae* and mixed infections:

The adult dose/drug schedule is as follows:-

A single dose of 600 mg Chloroquine (10 mg/kg body weight) and 15 mg Primaquine (0.25 mg/kg body weight) on the **first day** followed by 15 mg Primaquine (0.25 mg/kg body weight) daily for the next four days.

Table-3.7: The Age-wise Dosage of Radical Treatment

Age in years	Tablet Chloroquine		Tablet Primaquine	
	mg base Single dose	No. of tablets (150 mg)	mg base Daily dose for 5 days	No. of tablets (2.5 mg)
< - 1	75	½	nil	nil
1 - 4	150	1	2.5	1
5 - 8	300	2	5.0	2
9 -14	450	3	10.0	4
15 - >	600	4	15.0	6

In high risk areas where presumptive treatment with 1,500 mg Chloroquine has been given and the patient is found positive for *P.vivax*, dose of Chloroquine - 600 mg need not be administered but five days schedule of Primaquine must be given.

b. Radical Treatment for *P.falciparum* Infection:

If the load of malaria positive cases is very high in an area, *P.falciparum* cases who were given a single dose of presumptive treatment with 600 mg Chloroquine (i.e. 10 mg/kg.b.w.) should be given full radical treatment **on priority**.

The adult dose is:-

- 1,500 mg Chloroquine in three divided daily doses (i.e. 600 mg each on first and second day & 300 mg on third day) **plus** 45 mg Primaquine on first day.

This dose is suitably adjusted for other age groups.

CAUTION: Infants and pregnant women are not to be given Primaquine

c. Radical Treatment of cases in Chloroquine resistant strain areas for *P.falciparum* as suggested under the revised Drug Policy is as follows:-

Adult Dose

Sulfalene/Sulfadoxine
+ 1500 mg Single Dose
Pyrimethamine 75 mg
(3 tablets)
Thereafter
Primaquine 45 mg Single dose

These drugs should be given cautiously and not on the same day as both are known to precipitate haemolytic crisis in sensitive cases with G6PD deficiency. The drug administrator should ensure that the patient swallows Sulfa combination tablets in his presence and the patient is given clear instructions to consume Primaquine tablets on the following day without fail.

Table-3.8: The Age-wise Dosage

Age in years	Sulfalene/ Sulfadoxine + Pyrimethamine		Primaquine	
	Mg base	No. of tablets (500 mg + 25 mg)	Mg base	No. of tablets (15 mg)
1	2	3	4	5
> 1	125 mg + 6.25 mg	¼	nil	nil
1-4	500 mg + 25 mg	1	7.5 mg	½
5-8	750 mg + 37.5 mg	1 ½	15.0 mg	1
9-14	1000 mg + 50 mg	2	30.0 mg	2
15 & above	1500 mg + 75 mg	3	45.0 mg	3

In cases resistant to above drugs, and in severe and complicated malaria cases with *P.falciparum* infection (microscopically confirmed) I.V. Quinine is to be used in doses given below:-

Dosage of Quinine dihydrochloride I.V.

Quinine 10 mg/per kg b.w. thrice daily as intravenous infusion in 5% dextrose/glucose solution over 4 hours.

When patient regains consciousness, same dose schedule of Quinine is given orally to complete seven days treatment.

However, even in this area, the radical treatment to *P.vivax* will remain the same i.e. Chloroquine @ 10 mg/kg body wt on first day and Primaquine @ 0.25 mg/kg body wt daily from first day to fifth day.

Use of New Antimalarials by Registered Medical Specialists

1. Mefloquine can be used **only** for treatment of *P.falciparum* cases resistant to Chloroquine and not for *P.vivax* cases but it should be mandatory that **Mefloquine is issued only on the prescription by a qualified Registered Medical Specialist and the prescription is supported by laboratory report issued by a qualified Parasitologist indicating that there are *P.falciparum* rings (and not gametocytes alone) in the peripheral blood smear.**

2. Artemisinin and its derivatives can be used in management of severe and complicated *P.falciparum* infection in areas of resistant foci. The drug is to be made available in injectable form to prevent its misuse and careful monitoring of its distribution system is imperative.

Chemoprophylaxis

No true chemoprophylactic drug is available which acts directly on 'sporozoites' which prevents establishment of malaria infection in man (absolute prophylaxis). All antimalarials which are used for clinical chemoprophylaxis are schizonticidal drugs which do not prevent malaria infection but suppress appearance of clinical symptoms by acting on erythrocytic stages. Therefore, a good suppressive drug should have the following qualities.

a. It should be fast acting against erythrocytic stages.

b. It should have long half life so that frequent drug administration is not necessary.

c. It should not be toxic in the dosage required for suppressive treatment over prolonged period.

Drawbacks:

i. At present no such drug is available although 4-aminoquinolines are fast acting and safe enough. The Sulfa group with Pyrimethamine combination is quite effective but not safe due to toxic reactions if taken for a long period of time. People who are allergic to Sulfa drugs may develop skin lesions or agranulocytosis which at times may be fatal. The 4-aminoquinoline group of drugs produce skin reaction and permanent changes in eye - neuro-retinitis, if taken continuously for a number of years. Quinine is not suitable as it is to be administered more frequently and risk of Quinine toxicity and its severity is much more.

ii. The other drawback is that continuous uninterrupted drug compliance over a prolonged period during transmission period cannot be ensured.

iii. Discontinuation of treatment leads to breakthrough which may go untreated for long time.

iv. If the drug schedule is not strictly followed, chances of selecting a resistant strain of *P.falciparum* in the area increase.

Therefore, the suppressive treatment or chemoprophylaxis is not recommended for those who are permanent residents of meso or hyperendemic areas.

Most appropriate group who are benefited by the chemoprophylaxis are:-

a*. Tourists/travellers from non-malarious areas to malarious areas.

b*. Military or Paramilitary groups moving into malarious areas.

***Caution:** - The chemoprophylaxis or

suppressive treatment should be started a week before departure and not to be terminated immediately after leaving the malarious area and should be continued for at least 4 weeks more, irrespective of the fact that the person is afebrile and not positive for malaria parasite.

Chemoprophylaxis should be terminated with radical treatment schedule of five days at the recommended dosage.

c. Pregnant women in endemic and hyperendemic areas - chemoprophylaxis to be started after first trimester of pregnancy and continued for one month after child birth. However, before commencement of chemoprophylaxis, if a pregnant woman is found positive, give full course of Chloroquine. In the event of breakthrough during chemoprophylaxis, investigate drug compliance and administer full treatment with second line of drug.

Authors' remarks:

In the post-natal period at the time of termination of chemoprophylaxis, the Hb level should be estimated, if woman is still anaemic (Hb below 7 gm), the chemoprophylaxis should be continued along with treatment for anaemia and it can be terminated with Radical Treatment of five days duration when anaemia has been corrected.

1. The drug of choice for chemoprophylaxis in:

a. Chloroquine Sensitive Areas

Chloroquine	Dosage schedule 10 mg/kg.b.w. as loading dose and thereafter 5 mg/kg b.w. at weekly intervals. Not recommended beyond three years because of cumulative toxicity.

b. Chloroquine Resistant Areas

*Chloroquine +	5 mg/kg body wt at weekly interval (300 mg- adult dose)
Proguanil	1.5 mg/kg body wt daily (100 mg - adult dose)

***Note**: Since Proguanil is to be taken daily, drug compliance is poor.

2. Amodiaquine is not recommended for chemoprophylaxis because prolonged use of this drug produces serious toxic manifestations. Death rate due to toxic effects of Amodiaquine is more than the risk of death due to severe malaria infection. Therefore, Amodiaquine has now been withdrawn from the programme.

SECTION-4
RESISTANCE TO ANTIMALARIALS IN PLASMODIUM INFECTIONS

INTRODUCTION

Development of drug resistance in *Plasmodium* was reported world-wide from time to time. By 1950s reports were published on the development of resistance to Pyrimethamine in *P.falciparum*. Though Chloroquine has been in use since II World War, there were no reports on the emergence of resistant strains till 1960. Resistance of *P.falciparum* to Chloroquine was reported for the first time from Thailand during 1960 followed by Columbia in South America and in some South-East Asian countries like Bangladesh, Combodia, Malaysia, Myanmar, Indonesia and Vietnam. Chloroquine resistant *P.falciparum* infection was first reported in India from Diphu in Karbi Anglong district of Assam during 1973 and later in 1974 from Nawgaon district of the same State. Subsequently between 1973 and 1977 several field tests were conducted in a few States in the country such as Madhya Pradesh, Karnataka, Orissa, Tamil Nadu, etc. but no resistant focus was detected from these States.

However, *in-vivo* tests (mostly seven days) in North-Eastern States of Arunachal Pradesh, Assam, Mizoram and Nagaland where Chloroquine was in use for several years revealed widespread prevalence of Chloroquine resistant strains of *P.falciparum*. These results warranted monitoring of drug resistance problem through field studies on a larger scale.

Establishment of *P.falciparum* Resistance Monitoring Teams

Monitoring of drug resistance in *P.falciparum* was systematically taken up throughout the country by Govt. of India from 1978. Six *Pf.* Monitoring Teams were established in six Regional Offices for Health & Family Welfare, one each at Bangalore, Baroda, Bhubaneswar, Hyderabad, Lucknow and Shillong. A seventh team for conducting sensitivity trials with alternative drugs was also established at ROH & FW, Shillong. The extensive field tests revealed the presence of several pockets of resistant foci in Eastern and Central parts of India, besides North-Eastern States. These findings resulted in the establishment of six more monitoring teams to cover other endemic parts of the country. Thus 13 *P.falciparum* Monitoring Teams are currently working in the country.

The **objectives** of *P.falciparum* Monitoring Teams and the alternative drug trials are as follows:-

i. To detect and map out drug resistant foci with frequency and degree of Chloroquine and antimalarial resistance in *P.falciparum* throughout the country.

ii. To assess the response of *P.falciparum* to currently used antimalarials in order to establish and generate baseline data on sensitivity of the local strain.

The operational area for each monitoring team is allocated in such a way that all the endemic areas, especially those at high risk to *P.falciparum* infection, are covered in the entire country. Each monitoring team comprises of a Research Officer (Medical), eight laboratory assistants and ancillary staff. Each team is allotted an independent vehicle, equipments and material for conducting the field studies.

Definition of Resistance

Drug resistance in malaria has been defined as the 'ability of a parasite strain to survive and/or to multiply despite the administration and absorption of a drug given in doses equal to or higher than those usually recommended but within the limits of tolerance of the subject' (WHO : 1965, 1973).

Resistance by *P.falciparum* to Chloroquine, as well as to Proguanil and Pyrimethamine is attributable to selection under drug pressure of resistant mutants which survive by utilising

alternative metabolic pathways to those blocked by the particular drug. Resistance to Proguanil and Pyrimethamine is reported in other species of *Plasmodium.*

Gradation of Response to Drugs

There is wide spectrum of response to the drug by the asexual parasite, from mere survival at a sub-patent level with subsequent recrudescence in the blood to active multiplication during the course of treatment. A system of grading the responses of asexual stages of *P.falciparum* to normally recommended doses of Chloroquine has proved practical and useful. It has been postulated that the immune status of a patient is likely to modify the parasite response to Chloroquine and other antimalarials. The parasite clearance at the same dose and drug concentration in the plasma, the response in a semi-immune person is much faster than in a non-immune person and asymptomatic response will be even more prompt.

GRADING OF RESISTANCE OF ASEXUAL PARASITES *(P.falciparum)*

Response	Recommended Symbol	Evidence
Sensitivity	S	Clearance of asexual parasitaemia within 7 days of initiation of treatment without subsequent recrudescence.
Resistance	R I	Clearance of asexual parasitaemia as in sensitivity followed by recrudescence.
	R II	Marked reduction of asexual parasitaemia but no clearance.
	R III	No marked reduction of asexual parasitaemia.

Test Methodology

The WHO recommended techniques of *in-vivo* (7 day and 28 day) and micro *in-vitro* are followed for observing the resistance status of *P.falciparum* parasites to Chloroquine and other antimalarials. Wherever the standard or extended tests are not operationally feasible, simplified *in-vivo* tests (Day 0, Day 2 and Day 7) are also conducted.

Criteria for Selection of Area

i. Areas with intense malaria transmission showing predominantly *P.falciparum* infection.

ii. Areas from where therapeutic failure to drug is reported by the Medical Officers of Primary Health Centres.

iii. Areas experiencing malaria outbreaks.

iv. Project areas with tropical aggregation of labour from endemic areas.

v. Repeat studies where resistant focus has been detected earlier.

vi. Areas reporting high mortality due to malaria.

Criteria for Inclusion of Cases for the Study

P.falciparum cases with minimum parasitaemia of 1,000 asexual parasites per cmm blood are selected for study through fever surveys and also fever cases attending OPDs of PHCs/dispensaries. The screened cases without any evidence or history of consumption of Chloroquine (confirmed by urine

examination) prior to the test are selected for the study. Selected cases are then administered 25 mg Chloroquine per kg body weight in three divided oral doses of 10 mg, 10 mg and 5 mg per kg body weight single oral dose over three consecutive days respectively.

Chloroquine is administered in the initial three days after collecting blood smear from day 0 to day 7 and then followed as day 14, day 21 and day 28. Urine test is repeated on day 1 or day 2 to confirm absorption of Chloroquine.

The blood smears of cases declared resistant to the antimalarial by *P.falciparum* Monitoring Teams are cross-checked at the Dte. of NMEP for confirmation. The confirmed results of study are tabulated by the Central Coordinating Cell at the Dte. of NMEP according to the degree of resistance. The results are communicated to the respective State Health Authorities to accelerate containment measures for liquidation and prevention of spread of resistant foci.

Criteria for Declaration of Resistant Areas

The Expert Committee on Malaria - 1995 laid down the following criteria for declaring as Chloroquine resistant area:-

'A Chloroquine resistant PHC will be characterised by detection of more than 25% of R II and R III level cases in a minimum sample of 30 cases'.

The proportion of Chloroquine sensitive and resistant *P.falciparum* cases in the country during the last 18 years is given in Table- 3.9.

It is discernible from Table- 3.9 that the percentage of sensitive cases markedly declined during the last 18 years from 89.8% in 1978 to 7.6% in 1995. The decline in the sensitive (S) cases in the country was gradual and consistent. However, during 1994 the percentage of sensitive cases was lowest recording 0.8% (i.e. only 6 cases were found sensitive out of 793 cases tested). Simultaneously the S/R I cases showed parallel increase from 8.4% in 1978 to 76.5% in 1995.

The percentage of R I cases showed increase from 0.8% in 1978 to 42% in 1987 and 1988 but recorded declining trend in the subsequent years touching the nadir of 4.3% in 1994. The percentage of R II cases increased from 0.6% in 1978 to 5.3% in 1995 with marginal fluctuations in the intervening years. There was no marked increase in R III cases during the 18 years interval and the same ranged between nil and 10.3%. Interestingly the *Pf%* in the country was more than triple during the same interval and the drug resistance phenomenon is considered to be one of the contributing factors.

Statewise distribution of PHCs recording Chloroquine resistant *P.falciparum* cases is given in Table- 3.10.

The overall country data showed that 68.3% of the PHCs (246 out of 360) showed different grades of resistance. A total no. of 115 PHCs recorded R III level of resistance in the country during the last 18 years. R III level of resistance was not encountered in Assam, J&K, Kerala and Punjab during the last 18 years. The number of PHCs surveyed was very low in these States which ranged from 1 to 3 PHCs only. More surveys are to be carried out in the States/UTs to find out the current status of *P.falciparum* infection to Chloroquine. Among 24 States/UTs, where Chloroquine Sensitivity Tests were conducted during the last 18 years, Orissa and Haryana recorded resistant cases in 32 PHCs each followed by Bihar in 27 PHCs and Rajasthan in 21 PHCs. However most of these 'resistant foci' do not meet the criteria laid down by the Expert Committee - 1995 for declaring a PHC as resistant area.

In-vivo resistant status of *P.falciparum* to Chloroquine is given in the Map (Fig.- 3.1).

Epidemiological investigation proforma for monitoring *P.falciparum* resistance foci in given in Annexure- 3.1.

PHC areas with repeated studies as per the criteria are given in Annexure. 3.2.

Attempts were made to statistically analyse the data with a view to ascertain whether there is a significant difference in distribution of resistance status i.e. S, R I, R II and R III percentage in

the same area over a period of time or whether there is significant variation in resistant status of *P.falciparum* in different areas. However, due to small sample size, it was not possible to come to a statistically valid conclusion. It appears that the distribution of resistance to Chloroquine in *P.falciparum* and the degree of resistance i.e. percentage distribution of S, R I, R II and R III in an area due to selection may vary from time to time in the same area. This is probably governed by genetic factors of *P.falciparum* strain present in the area as well as human population in the locality, drug pressure to which the strain was subjected to in the past, time of study in relation to period of transmission and exposure of persons to malaria who were included in the study and resulting immune status of individual cases. In our opinion most important factor which determine the distribution of resistant strains is the prolonged drug pressure in the community with sub-therapeutic dosage of antimalarial.

Table-3.9 : *In-vivo* Chloroquine Sensitivity Studies (Year-Wise)

Year	Total Cases Tested	No. Sensitive	No. S/R I	No. R I	No. R II	No. R III	SfR	*Pf* %
1978	526	473 (89.8%)	44 (8.4%)	4 (0.8%)	3 (0.6%)	2 (0.4%)	0.907	13.24
1979	704	572 (81.3%)	64 (6.1%)	43 (6.1%)	15 (2.4%)	10 (1.4%)	0.909	18.22
1980	644	452 (70.2%)	89 (13.8%)	74 (11.5%)	26 (4.0%)	3 (0.5%)	0.875	20.29
1981	392	252 (64.3%)	45 (11.5%)	76 (19.4%)	17 (4.3%)	2 (0.5%)	0.869	21.83
1982	457	253 (55.4%)	71 (15.5%)	95 (20.8%)	31 (6.8%)	7 (1.5%)	0.847	25.25
1983	289	146 (50.5%)	87 (30.1%)	46 (16.0%)	9 (3.1%)	1 (0.3%)	0.935	29.77
1984	434	227 (52.3%)	160 (36.9%)	36 (8.3%)	11 (2.5%)	0 (0.0%)	0.990	30.01
1985	484	89 (18.4%)	311 (64.2%)	61 (12.6%)	22 (4.6%)	1 (0.2%)	0.890	29.23
1986	568	183 (32.2%)	121 (21.3%)	217 (38.2%)	39 (6.9%)	8 (1.4%)	0.940	35.61
1987	763	300 (39.3%)	85 (11.1%)	319 (41.8%)	31 (4.1%)	28 (3.7%)	0.850	37.19
1988	600	185 (30.8%)	76 (12.7%)	250 (41.7%)	27 (4.5%)	62 (10.3%)	0.910	36.95
1989	498	92 (18.5%)	250 (50.2%)	87 (17.5%)	20 (4.0%)	49 (9.8%)	1.050	36.87
1990	679	137 (20.2%)	298 (43.9%)	158 (23.3%)	48 (7.0%)	38 (5.6%)	1.010	37.36
1991	541	102 (18.9%)	311 (57.5%)	50 (9.2%)	34 (6.3%)	44 (8.1%)	1.220	43.38
1992	1045	134 (12.8%)	646 (61.8%)	135 (12.9%)	61 (5.8%)	69 (6.6%)	1.100	41.22
1993	782	56 (7.1%)	538 (68.8%)	61 (7.8%)	71 (9.1%)	56(7.2%)	1.094	38.63
1994	793	6 (0.8%)	663 (83.6%)	34 (4.3%)	62 (7.8%)	28 (3.5%)	1.205	39.43
1995	617	47 (7.6%)	472 (76.5%)	39 (6.3%)	33 (5.3%)	26 (4.2%)	1.149	34.50

Table- 3.10 Statewise Distribution of PHCs Recording Chloroquine Resistant *P.falciparum* Cases in India from 1978 to 1995

S. No.	Name of the State/UT	No. of PHCs Surveyed	No. of PHCs Resistant	R I	R II	R III	R I + R II	R I + R III	R II + R III	R I + R II + R III	*In-vitro* Resistance
1.	Andhra Pradesh	33	16	9	0	0	1	1	0	2	3
2.	Arunachal Pradesh	6	4	1	0	0	1	0	0	2	0
3.	Assam	3	2	0	0	0	2	0	0	0	0
4	Bihar	34	27	5	2	0	3	3	3	11	0
5.	Gujarat	16	12	2	0	0	3	0	2	4	1
6.	Haryana	46	32	2	4	5	4	2	3	10	2
7.	Himachal Pradesh	11	5	2	2	0	0	0	0	2	0
8.	Jammu & Kashmir	1	1	1	0	0	0	0	0	0	0
9.	Karnataka	40	18	4	1	0	4	3	0	6	0
10.	Kerala	1	1	1	0	0	0	0	0	0	0
11.	Madhya Pradesh	23	13	6	2	0	0	2	0	2	2
12.	Maharashtra	3	3	1	0	0	1	0	0	1	0
13.	Manipur	16	9	3	2	0	2	0	1	0	1
14.	Meghalaya	13	11	3	0	1	1	2	2	2	0
15.	Mizoram	5	5	0	0	0	2	1	0	2	0
16.	Nagaland	3	3	0	0	1	0	0	0	1	1
17.	Orissa	38	32	5	4	1	8	3	0	9	2
18.	Punjab	3	3	0	1	0	0	0	0	0	2
19.	Rajasthan	21	21	4	2	0	5	4	0	7	0
20.	Tamil Nadu	1	1	0	0	0	0	0	0	1	0
21.	Tripura	2	2	0	0	0	1	1	0	0	0
22.	Uttar Pradesh	35	12	5	0	0	5	0	3	0	1
23.	West Bengal	13	12	0	1	3	1	2	1	4	0
24.	U.T. of Delhi	31	1	0	0	1	0	0	0	0	0
Total		**360**	**246**	**54**	**18**	**12**	**44**	**24**	**13**	**66**	**15**

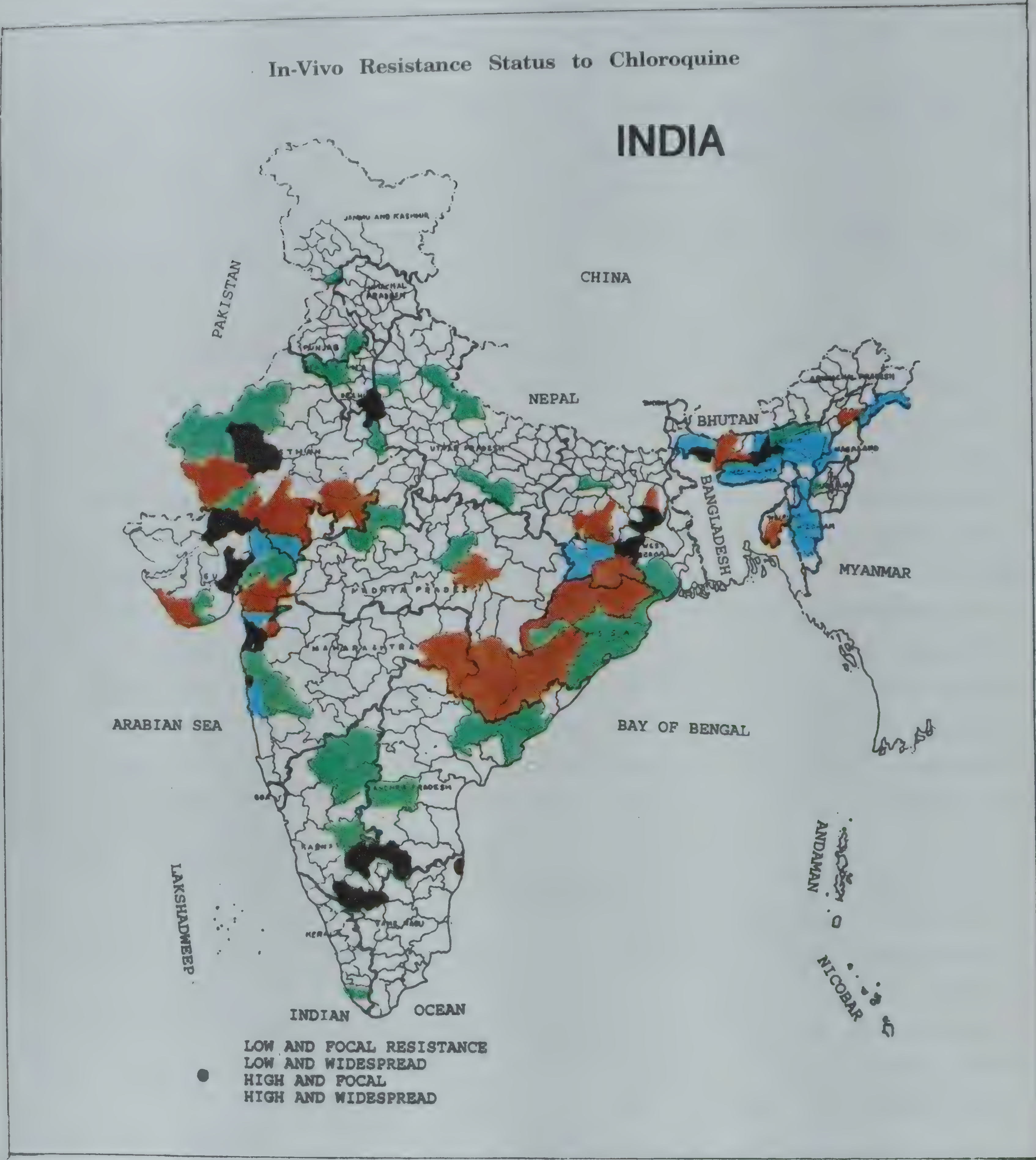

In-Vivo Resistance Status to Chloroquine
INDIA
CHINA
PAKISTAN
NEPAL
BHUTAN
BANGLADESH
MYANMAR
ARABIAN SEA
BAY OF BENGAL
LAKSHADWEEP
ANDAMAN
NICOBAR
INDIAN OCEAN
LOW AND FOCAL RESISTANCE
LOW AND WIDESPREAD
HIGH AND FOCAL
HIGH AND WIDESPREAD

Fig- 3.1

Annexure: 3.1

DETAILS OF EPIDEMIOLOGICAL INVESTIGATIONS IN PHC

A. Parasitological*	19..	19..	19..	19..	19..
1. ABER					
2. Average MBER in transmission months (indicate transmission months)					
3. % age RT given to *Pf* cases					
4. Average number of days between fever incidence and blood smear collection of *Pf* cases					
5. Average number of days between blood smear collection and RT of *Pf* cases					
6. Name of drugs & dosage (Adult dose)					
7. Ratio of ACD & PCD					
8. Other Epidemiological parameters:					
i). SPR					
ii). SfR					
iii). API					
iv). AfI					
v). *Pf* %					
vi. Deaths due to malaria					

Year	No. of Deaths						Total
	Sex	<1	1-4	5-8	9-14	above 14 yrs.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
19 ..	M						
	F						
19 ..	M						
	F						
19 ..	M						
	F						

* A minimum data for two years preceding the first detection of resistant strains and intervening period between follow-up surveys should be reflected in vertical columns opposite A.1 to A. 8

9. Mass survey results, if any

Transmission Intervention

1). Name of insecticide used

2). % of Rooms covered with actual dates of spray period

Round	Date		% of Room Coverage	% of HD Refused	Remarks
	From	To			
I					
II					
III					
Special round if any,					

3. a). Whether sprayed within the spray schedule. If not, % age of Human dwellings sprayed outside the schedule period (Average of all rounds)

   b). Reasons for refusal, poor coverage and failure to keep to schedule dates

4. Quality of spray, if information is available

5. Any other intervention measures undertaken (specify)

6. Whether cattle sheds sprayed* (earlier data) If so, percentage sprayed (average of all the rounds)

* As per the Operational Guidelines of Malaria Action Programme - 1995, the cattle sheds are not to be sprayed.

Annexure - 3.2

P.f. Resistance to Chloroquine: Areas with repeated studies (As per criteria)

S. No.	State/Distt.	PHC/Area	Year	Total cases treated	Resistance Level S	S/RI	RI	RII	RIII	Chloro-quine dose	Period of Survey	Epidemiologycal Data of the Areas Surveyed No. of villages Surveyd	Popn. Surveyd	BSE	Tot. +ve	P.v.	P.f.	Mix
1.	ANDHRA PD.																	
	1. East Godavari	Maredu-milli	1991	17	-	17	-	-	-		July	10	N.A.	608	28	3	22	3
			1993	43	-	37	3	1	2	600 mg	June	20	8929	1939	209	19	189	1
			1993	29	-	28	-	1	-	1500 mg	Oct.							
				24	-	19	1	2	2	600 mg	Oct.	12	7392	1541	129	20	109	-
	2. V.S.P		1988	16	5	5	5	1	-		Jan.	N.A.	N.A.	2094	92	33	54	5
			1991	30	-	27	-	2	1		Aug./Sep.	5	N.A.	158	41	2	39	-
2.	ASSAM																	
	1. Karbi-Anglong	1. Manja	1979	131	40	56	24	5	6		July	N.A.						
			1982	17	4	7	3	3	-		June/July							
			1984	10	-	9	1	-	-	7 day test	July							
			1984	31	24	1	6	-	-		July							
			1986	58	21	29	7	1	-									
			1988	29	9	-	16	4	-		Aug./Sep.	N.A.	N.A.	673	230	18	207	5
			1990	15	7	1	1	3	3		Oct./Dec.			604	130	-	126	4
		2. Bokajan	1979	18	6	3	5	1	3		Aug./Sep.	N.A.						
			1982	26	12	5	6	2	1		June/July							
			1986	46	17	9	17	3	-									
			1993	14	-	13	-	-	1		Dec./Jan.				262	N.A.		
	2. Kamrup	1. Sonapur	1980	27	-	19	7	1	-		Aug./Sep.							
			1985	24	13	-	11	-	-	7 day test		N.A.						
			1985	14	10	-	4	-	-	7 day test								
			1990	22	7	-	14	1	-		Sept./ Nov.			292	84	3	79	2
		2. Boko	1983	52	-	33	18	1	-	7 day test	Aug.							
			1985	32	-	30	1	1	-			N.A.						
			1987	47	10	-	32	4	1									
			1990	17	6	1	3	5	2		Dec.			477	180	13	167	-
			1992	33	15	0	13	2	3		Aug./ Sept.	N.A.	N.A.	204	125	-	125	-

S. No. State/Distt.	PHC/Area	Year	Total cases treated	Resistance Level S	S/RI	RI	RII	RIII	Chloro-quine dose	Period of Survey	Epidemiologycal Data of the Areas Surveyed: No. of villages Surveyd	Popn. Surveyd	BSE	Tot. +ve	P.v.	P.f.	Mix
3. Goalpara	Ranguli	1988	19	14	-	4	-	1		May/ June			1125	128	8	120	
		1990	19	8	-	9	2	-		Sept./Oct.			711	90	1	89	-
4. Kokrajar	Sidhi	1985	40	16	8	9	7	-									
		1988	21	11	-	10	-	-		Aug./ Sep.			1077	261	3	257	1
5. Nalbari	Tamalpur	1990	26	6	1	10	8	1		July/Aug.			1028	217	21	191	5
		1992	20	6	3	4	2	5		July/ Aug.			645	213	10	200	3
6. Dhubri	Chhapar	1990	27	7	1	15	1	3		July./ Aug.			651	248	5	241	2
		1993	34	-	25	1	7	1		Aug./ Sept.	4	7150	295	106	21	83	2
3. BIHAR																	
1.Singhbhum	Mono-harpur	1985	60	-	51	5	4	-									
		1992	17	-	14	3	-	-	-	July		N.A.	266	93	19	73	1
2. Gumla	Simdaga	1984	21	-	20	1	-	-			N.A.						
		1992	37	-	29	3	1	4	7 day test	Nov./Dec.		N.A.	427	293	6	282	5
4. GUJARAT																	
1. Surat	Uttavan	1984	11	10	-	1	-	-									
		1984	24	-	20	4	-	-	7 day test								
		1987	77	24	1	46	2	4									
2. Baroda	In clinic	1984	39	-	37	1	1	-									
		1985	1	-	1	-	-	-	28 day test	Jan.							
		1985	21	-	17	2	1	1	7 days test	Sept.							
		1992	40	13	26	-	1	-	N.A.	Nov.			2860	228	22	205	1

S.State/Distt. No.	PHC/Area	Year	Total cases treated	Resistance Level S	S/RI	RI	RII	RIII	Chloro-quine dose	Period of Survey	Epidemiologycal Data of the Areas Surveyed: No. of villages Surveyd	Popn. Surveyd	BSE	Tot. +ve	P.v.	P.f.	Mix
3. Banas-kanta	Tandav	1990	21	-	19	1	1	-		Dec.			545	124	13	110	1
		1994	50	-	46	-	4	-		Nov.	6		310	114	8	106	-
4. Sabar-kanta	Poshina	1992	26	8	1	2	3	12		Nov./Dec.			441	87	7	80	-
		1993	27	-	23	-	1	3	-	Oct.	4	5355	511	141	41	98	2
5. KARNATAKA																	
1. Gulbarge	Kakkera	1985	15	-	14	-	1	-									
		1986	16	6	5	5	-	-									
		1987	34	15	-	15	2	2			N.A.						
2. Tumkur	Chellur	1988	25	9	6	9	-	1		June/July			352	98	33	65	-
		1990	22	3	5	14	-	-		May/ June			173	88	13	73	2
		1992	18	3	-	9	3	3		July			586	104	9	95	-
		1993	18	-	13	-	3	2		Nov./ Dec.							
3. Chittradurga	Dindavara	1978	35	35	-	-	.	.									
		1988	30	6	2	20	-	2		Apr./ May			475	170	76	91	3
4. Kolar	Ganzigunta	1981	27	27	-	-	-		7 days test								
		1981	28	28	-	-	-	-									
	Gulur	1992	58	9	-	21	16	12		June/ July			845	399	172	216	11
		1993	24	3	5	9	5	2		June	5	3800	321	126	67	58	1
5. Bijapur	Konnur	1986	37	11	1	25	-	-									
		1987	24	14	1	9	-	-			N.A.						
7. MADHYA PRADESH																	
1. Mandla	Bijadandi	1993	21	-	18	2	-	1				2604	2604	339	234	104	1
		1994	25	-	22	-	3	-		Nov.		N.A.	248	111	57	54	-
8.MAHARASHTRA																	
Gadcharoli	Bhamra-gaon	1987	20	20	-	-	-	-			N.A.						
		1989	19	18	-	1	-	-		Nov.			532	57	14	40	3

S. No. State/Distt.	PHC/Area	Year	Total cases treated	Resistance Level S	S/RI	RI	RII	RIII	Chloro-quine dose	Period of Survey	Epidemiologycal Data of the Areas Surveyed: No. of villages Surveyd	Popn. Surveyd	BSE	Tot. +ve	P.v.	P.f.	Mix
9. MEGHALAYA Garohills	Zikzoke	1988	20	14	5	1	-	-		May/ June			807	219	15	202	2
		1990	27	20	1	-	3	3		Dec.			434	117	8	109	-
10.MIZORAM	Hanthial	1983	24	20	-	1	3	-			N.A.						
Lunglei		1989	24	-	14	1	1	8		Apr./ May			2560	500	21	479	-
11.NAGALAND	Dimapur	1984	34	24	-	9	1	-									
Kohima		1988	23	5	-	8	3	7		Aug./ Sept.			785	285	30	245	10
12. ORISSA																	
1.Phulbani	Phiringia	1987	20	13	4	1	-	2			N.A.						
		1989	25	-	19	2	1	3		Nov.			227	147	32	113	2
2. Kalahandi	Jaipatna	1986	21	-	19	2	-	-			N.A.						
		1990	9	-	9	-	-	-		Sept.			435	93	24	69	-
3. Keonjhar	Padampur	1983	4	-	2	2	-	-			N.A						
		1988	32	3	4	23	1	1		July			568	214	64	146	4
4. Ganjam	Polisara	1979	19	18	1	-	-	-									
		1982	27	10	3	12	2	-									
		1984	19	3	11	3	2	-									
5. Mayurbhanj	Kaptipada	1983	31	20	5	6	-	-									
		1991	13	-	13	-	-	-		Sept./Oct.		11	471	103	24	79	
13. RAJASTHAN																	
1.Bharatpur	Roopbas	1980	30	30	-	-	-		7 days test								
		1984	33	32	-	1	-	-									
2. Banswada	Kushal-garh	1988	14	1	4	8	1	-		Oct./Nov			195	103	16	80	7
		1993	12	-	9	-	3	-		Oct /Nov	5	2512	150	39	6	22	11
	Talwara	1987	17	9	-	6	-	2									
		1989	13	5	3	3	-	2		Nov./Dec			442	62	8	52	2
3. Dungarpur	Bichhi-wara	1987	18	2	-	13	1	2									
		1989	15	5	1	6	1	2		Sept.			508	184	30	154	-
		1993	35	-	26	1	4	4		Jan/Fab	2	5202	420	125	4	121	-

S. No.	State/Distt.	PHC/Area	Year	Total cases treated	Resistance Level					Chloro-quine dose	Period of Survey	Epidemiologycal Data of the Areas Surveyed						
					S	S/RI	RI	RII	RIII			No. of villages Surveyd	Popn. Surveyd	BSE	Tot. +ve	P.v.	P.f.	Mix
	4. Udaipur	Rishabdar	1987	29	8	3	14	2	2									
			1991	27	5	8	11	3	-		Oct/Nov.	23		332	83	2	81	-
	5. Barmer	Baitu	1990	59	11	4	38	2	4		Dec.			701	460	21	432	7
			1992	33	-	29	1	2	1		Nov.			491	118	19	98	1
			1994	12	-	7	-	3	2		Oct.	6		169	55	3	52	-
	6. Jodhpur	Salawas	1991	11	-	-	5	2	4		Dec.	4		222	69	7	55	7
			1994	30	-	25	-	5	-		Dec.	2		251	92	6	84	2
	7. Jaisalmer	Pokhran	1992	20	9	2	9	-	-					345	107	7	100	-
			1994	10		10	-	-	-		Oct.	2		474	266	6	252	8
14.	TAMILNADU Madras city	Madras-city	1984	20	19	-	1	-	-									
			1984	12	-	12	-	-	-									
15.	UTTAR PRADESH 1. Allahbad	Meja	1992	24	-	23	1	-	-		Sept	.	N.A.	269	93	59	34	-
			1993	21	-	21	-	-	-		Sept.	4	N.A.	353	37	16	21	-
	2. Mirzapur	Muirpur	1979	36	36	-	-	-	-						N.A.			
			1981	19	2	-	17	-	-						N.A.			
16.	WEST BENGAL 1. Purulia	Ayodhya Hills	1981	50	19	10	16	4	1									
			1987	15	8	-	7	-	-									
			1991	24	-	15	-	-	9		Mar./Apr	6	N.A.	278	72	9	61	2
			1992	31	-	25	-	3	3		Mar/Apr	-	N.A	354	120	21	96	3
			1993	37	-	24	1	5	7		Aug.	7	N.A.	115	72	8	62	2
	2. Jalpaiguri	1. Uttari-tabari	1987	32	7	5	17	2	1									
			1988	11	2	2	4	3	-		Sept/Oct.			670	371	138	233	-
			1990	32	-	21	-	-	11		Sept.			410	116	30	85	1
		2. Kama-khyguri	1984	8	8	-	-	-	-									
			1984	13	13	-	-	-	-									
			1992	50	-	47	-	2	1		July			821	178	33	143	2
			1994	27	-	21	3	-	3		Sept.	4	N.A.	852	174	10	160	4
		3. Panch-kalguri	1986	60	17	-	33	10	-									
			1989	25	-	16	2	-	7		Aug.			392	139	-	139	-
		4. Falakata	1989	20	-	18	-	-	2		June			310	148	31	117	-
			1991	41	34	-	-	3	4		Julys	2	N.A.	292	109	18	88	3

1. Bruce. Chwatt. L.J. Ed. (1986): Chemotherapy of malaria. Revised edition, World Health Organisation, Geneva.

2. Peters, W. (1970): Chemotherapy and drug resistance in malaria. Academic Press, London and New York.

3. World Health Organisation (1975): Guidelines for evaluation of drugs for use in man. *Tech. Rep. Ser. No.* **563** Geneva.

4. World Health Organisation (1977): Chemotherapy of malaria and resistance to antimalarials. *Tech. Rep. Ser. No.* **529** Geneva.

5. World Health Organisation (1984): Advances in Malaria Chemotherapy. *Tech. Rep. Ser. No.* **711** Geneva.

6. World Health Organisation (1990): Practical chemotherapy of Malaria. *Tech. Rep. Ser. No.* **805** Geneva.

7. Wyler, D.J. (1983): Resurgence resistance and research. *The New England Journal of medicines,* **308**: 875-940.

SELECTED REFERENCES

1. Bruce. Chwatt. L.J. Ed. (1986): Chemotherapy of malaria. Revised edition, World Health Organisation, Geneva.

2. Peters, W. (1970): Chemotherapy and drug resistance in malaria. Academic Press, London and New York.

3. World Health Organisation (1975): Guidelines for evaluation of drugs for use in man. *Tech. Rep. Ser. No.* **563** Geneva.

4. World Health Organisation (1977): Chemotherapy of malaria and resistance to antimalarials. *Tech. Rep. Ser. No.* **529** Geneva.

5. World Health Organisation (1984): Advances in Malaria Chemotherapy. *Tech. Rep. Ser. No.* **711** Geneva.

6. World Health Organisation (1990): Practical chemotherapy of Malaria. *Tech. Rep. Ser. No.* **805** Geneva.

7. Wyler, D.J. (1983): Resurgence resistance and research. *The New England Journal of medicines,* **308**: 875-940.

4

CLINICAL MALARIA

SECTION - I
DIFFERENTIAL DIAGNOSIS

INTRODUCTION

The clinical picture of malaria, its differential diagnosis, management of uncomplicated and complicated cases have been extensively dealt with in different text books of medicine. A large number of monograms on this subject have been published by WHO and Directorate of NMEP, Delhi. In this chapter, the subject has been dealt with keeping in view the limitations usually encountered in the field operations of malaria control programme. The epidemiological status of the locality modifies the clinical picture of malaria case(s). The clinical picture shows wide variations in different malaria paradigms. The management of malaria cases at different levels of health delivery system has its own drawbacks because sometimes essential facilities are not available at the primary, secondary and even tertiary referral centres of health care system. The Medical Specialists at different levels are sometimes not aware of latest developments in malaria chemotherapy and case management. An attempt has been made in this chapter to provide updated information on the subject.

Malaria was called as the king of diseases by Charaka and Susruta, great Indian Physicians of Ayurveda. It is an apt description of the disease as malaria infection produces clinical symptoms of diverse nature and can mimic many other diseases. To understand the course of clinical events in a malaria case, its clinical pathology should be properly understood.

Incubation period in human host varies with species of malaria parasite infecting a person. The incubation period is described as lapse of period between introduction of sporozoites in the body and appearance of clinical symptoms. The sporozoites enter the cells within half an hour of inoculation and develop in the hepatocytes. The incubation period is usually from 9 to 28 days. It is shortest for *P.falciparum* and longest for *P.malariae*.

P.falciparum	Average incubation period is 12 days, range being 9 to 14 days.
P.vivax	Average incubation period is 15 days, range being 12 to 17 days. Some *P.vivax* strains show a much longer incubation period up to 6-12 months.
P.malariae	Incubation period is 28 days, range being 18 to 40 days or even more.

After completion of pre-erythrocytic cycle, the merozoites are liberated from liver in the peripheral circulatory system. These merozoites then infect the RBCs. In non-immune cases, **prodromal symptoms** are presented. During this stage, the malaria parasite may not be microscopically

demonstrated in the peripheral blood.

Prepatent period is the period between inoculation of sporozoites and demonstrable parasitaemia in the peripheral blood.

CLINICAL COURSE OF PAROXYSM IN UNCOMPLICATED MALARIA

Cold Stage:-

The clinical symptoms of malaria start with shivering (rigor). During this stage the shivering may range from the feeling of chill to uncontrollable shivering with intense cold which is not relieved even if the patient covers himself with clothing and blankets. This period lasts for ½ to 2 hours. During this period, the pulse is rapid but weak, lips and fingers may show cyanosis. The skin is usually dry and pale. During cold stage, vomiting may occur in some cases especially children.

Hot Stage - Fever Episode:-

The cold stage is immediately followed by hot stage. The intense cold gives way to distressing heat. The patient usually throws away the covering clothes. Temperature may sometimes rise up to 41° C (106° F). During this period, skin is dry, burning, intense headache, nausea and vomiting are common. There may be visual disturbances, diplopia, photophobia, disorientation and convulsions especially in young children. The temperature lasts for a period of 8 to 12 hours.

Remission of Fever - Sweating Stage:-

The temperature comes down by crisis with profuse sweating often below normal levels. This stage is called the sweating stage. The sweating may be so extensive that bedding becomes drenched with sweat. The patient is exhausted and sometimes goes into deep sleep; otherwise he feels normal. The sweating stage may last 2 to 4 hours.

Fever Free Period:-

After the fever episode, the patient may have a fever free period. Periodicity of fever episode is 36 to 48 hours in case of *P.falciparum* and 48 hours in *P.vivax*. In case of *P.malariae* the periodicity of fever is 72 hours.

Periodicity of Fever:-

In the initial stage of malaria infection intermittent periodicity of fever may be absent or in cases where more than one brood of liver merozoites are liberated in blood circulation immediately one after the other. Gradually after 2 to 3 bouts of fever, the periodicity is more or less well established.

Therefore, in the beginning, the fever episode accompanied with intense headache, fatigue, nausea, muscular pains, is more often mistaken for influenza or other bacterial or viral infections.

The above picture is presented by an uncomplicated case of malaria usually *P.vivax* and *P.malariae* and quite often by *P.falciparum*.

Clinical Presentation in Children

In children, the clinical symptoms may be accompanied with convulsions and disorientation which are attributed to hyperpyrexia. The pyrexia is usually very high.

The clinical picture in case of *P.falciparum* shows a lot of variations. How often these variations are presented depends on a large number of factors including the number of sporozoites inoculated, the immune status of the individual and most probably *P.falciparum* strains infecting the individual.

CLINICAL PATHOLOGY

To understand the further course of clinical manifestations in malaria patients, it is necessary to review the clinical pathology of malaria infection. The invasion of red blood cells by merozoites liberated from the liver is the basic pathological process of malaria infection. The factors which determine the course of reaction of the host to parasite invasion are governed by:-

i. Action of *Plasmodium* or its metabolic products on RBC.

ii. General changes in blood flow related to pyrexia and altered biochemistry of the body.

iii. Local changes due to damage to endothelial

cells of the blood vessels caused by parasitic products.

iv. Tissue toxaemia resulting from the metabolic products of the plasmodia.

v. Tissue anoxia due to decrease in oxygen carrying capacity of the blood and changes in the capillary endothelium.

Changes in RBC :-

When the malaria parasite enters the RBC, it produces morphological changes in RBC. In case of *P.vivax*, RBC is enlarged. In case of *P.falciparum*, knob like structures appear on the cell wall of RBC. These have been clearly observed under electron microscope. How and why these knobs appear is not yet fully understood. It is thought that these knob like structures produce cyto-adherence in RBCs infected with *P.falciparum*. These RBCs adhere to **i)** each other, **ii)** normal RBCs and also **iii)** the walls of the capillaries. It is thought that some of the biochemical products of parasite metabolism which are toxic in nature, produce damage to the endothelial cells of the capillaries and render them more permeable to fluids. In some instances, they allow trans-migration of white blood cells into the surrounding area.

The cyto-adherence of parasite results in blockage of capillaries and retards flow of blood in the area resulting in anoxemia of the surrounding tissues. All aspects of the process of altered biochemistry of human body during malaria infection are not very clearly understood.

Pathogenesis of fever in man is supposed to be the response of human body to toxic products of the infecting agent or indigenous products from destroyed RBCs. On the other hand, it may be the interaction of specialised receptors on thermo sensitive centres of hypothalamus, resulting in release of some chemicals stimulating vaso-constriction of peripheral vessels, decreasing the heat loss with resultant hyperthermia. However, the body response as witnessed during cold stage prior to hyperpyrexia may be a part of human reaction akin to other allergic reactions triggered by parasite toxins and RBC debris released at the time of liberation of merozoites from the RBCs because the cold stage starts immediately after the release of merozoites in the peripheral blood.

Most of the other manifestations in *P.falciparum* malaria develop from one simple pathology of cyto-adherence in RBCs. In whichever part of the internal organ the flow of blood is restricted due to the cyto-adherence and damage to capillary endothelium, the symptoms related to the organ concerned are manifested such as cerebral symptoms, symptoms of congestion of gastro intestinal or respiratory organs i.e. lungs and intestinal system. Some of the symptoms may be due to restriction of blood flow through the endocrinal glands. The nephrotic symptoms are due to the damage to the kidney tubules. Due to rapid destruction of RBCs in *P.falciparum* malaria, where the parasitised RBCs are destroyed as well as some of the normal RBCs are also haemolysed, producing severe anaemia during the course of a fever episode. Even in patients having moderate peripheral parasitaemia, with each bout of fever 0.5 gm of haemoglobin is lost from peripheral circulation. Thus repeated bouts of fever, produce sudden fall in haemoglobin and reduce oxygen carrying capacity of blood to levels which results in hypoxia of the tissues. There is rise in bilirubin in plasma and urine directly or indirectly depending on quantum of destruction of RBCs per fever bout and liver damage. There is excretion of albumin in urine along with red blood cells, hyaline and granular casts when acute renal dysfunction develops.

The spleen is enlarged due to the fact that reticuloendothelial system has to cope up with a very large amount of RBC debris and other products of parasite. In the initial stage spleen is just palpable on deep breathing and is tender. Therefore, it is clear that clinico-pathological picture of malaria infection which arises out of a simple invasion of RBCs by malaria parasite becomes very complex. As the disease progresses, the pathological process in different organs once initiated continues till the parasitaemia is controlled.

Anaemia and Bone Marrow Depression :-

Anaemia is most pronounced in malaria infections. It is quite severe in case of untreated acute *P.falciparum* infection. Severe anaemia is also

encountered in untreated long standing *P.vivax* cases. The blood picture is adversely affected during malaria infection due to depression of haemopoietic system including bone marrow. However, severe anaemia is rarely the cause of death in malaria even in *P.falciparum* cases. Recovery of hemopoietic system is often slow, despite parasitic cure. Sometimes it may be due to the effect of chemotherapeutic drugs used for treatment of malaria, like Pyrimethamine which produces delayed recovery from anaemia. The bone marrow response to malaria infection is normoblastic and monocytic generally with well marked erythroplastic hyperplasia. During malaria infection in pregnancy, severe anaemia is noticed in endemic areas. If the infection is not treated well in time, it is a common cause of mortality in pregnant women. In *P.falciparum* malaria, anaemia coupled with concentration of parasites in placenta produces hypoxia of foetus leading to foetal distress and abortion. This is quite common and serious in primiparous women especially in poor sections of the society who commonly suffer from low haemoglobin concentrations.

Intravascular Coagulation and Bleeding Tendency in *P.falciparum* Malaria:-

Intravascular coagulation is relatively rare and occurs late during the sickness. There is some evidence of reduced capability of clotting due to decrease in plasma coagulation factors and reduced platelet concentration. Platelets are probably entrapped in the spleen. Haemostatic alteration sometimes includes low plasma fibrinogen level, decreased platelet count resulting in haemorrhages. In late stages disseminated intravascular coagulation develops in association with thrombocytopaenia, fibrynogenopaenia and low levels of other coagulation factors and it adds to the mortality and morbidity of severe *P.falciparum* cases.

Cardiac Lesions :-

In severe cases, the petechial haemorrhages in the epicardium capillaries are sometimes full of numerous parasitised cells. The phenomenon may lead to degenerative changes in the cardiac muscle fibres, sometimes myocardial infraction has been reported. Among the other circulatory signs, drop in blood pressure may be seen. In stages of shock, the blood pressure falls dramatically and pulse rate reaches 150 per minute or above and is hardly perceptible. Peripheral vascular resistance is decreased because of orthostatic hypotension. Blood circulation in skeletal muscles is disturbed. There is loss of vascular tone in patients with low blood pressure especially just after a severe febrile attack.

Most of these clinico-pathological changes are reversible, unless parasitaemia is allowed to continue unabated in the host. In the long run some of the organs are irreversibly damaged. The internal factors which modify the human response to malaria infection are humoral and cellular response of the immune system as well as the nutritional status of the host.

CLINICAL DIAGNOSIS OF MALARIA PAROXYSM

It is not difficult to clinically diagnose a case presenting classical symptoms of malaria i.e. chills/ shivering followed by hyperpyrexia which resolves by crisis with profuse sweating. Fever invariably comes with typical periodicity. If associated with splenic enlargement and anaemia, which are usually encountered in chronic cases, clinical diagnosis of malaria in these patients is almost certain and laboratory confirmation is a mere formality. **However all malaria patients do not show typical sign and symptoms as mentioned above. Malaria symptoms are modified by the immune status, age, sex, pregnancy, and presence of any other concomitant disease.**

1. *P.vivax* INFECTION:

A. Clinical Picture:

Cold stage: Patient gets a chilly sensation or uncontrollable shivering (rigor) lasting about 1/2 to 2 hours followed by a rise in temperature.

Hot Stage - Fever Episode:

- The fever may last for 8 to 10 hours
- May occur daily or in a well developed classical case on alternate days.- (Benign Tertian malaria).
- May range up to 104^0 F and above.

- During fever stage, headache, bodyache and vomiting occur.

Remission of Fever - Sweating Stage:

- The fever goes down by crisis after profuse sweating.

- After remission of fever patient feels weak but relieved.

- Other symptoms also disappear.

Other Sign & Symptoms:

- After about 3-6 paroxysms, spleen is palpable.

- In a few cases, liver is just palpable and tender.

- Relapses end in three to five years even without treatment.

- The clinical course of the disease is mild and periodicity is well established even in the initial stages.

- Infants and young children with hyperpyrexia may show disorientation and convulsions. Because of the above, clinical condition is misleading, the patient may be mis-diagnosed as suffering from *P.falciparum* infection or some other ailment involving central nervous system.

Therefore, to arrive at final diagnosis the correct species identification by microscopy assumes great importance in case of infants and children.

B. The Management of a Patient with *P.vivax* Malaria:

1. Control high temperature.

2. Specific antimalarial treatment.

3. Relief from headache and bodyache.

4. Control of disorientation and convulsions in infants and children.

5. Correct dehydration resulting from low water intake and long standing hyperpyrexia.

Table-4.1: Salient Features of Malaria-Different Species

SPECIES	SEVERITY OF SIGN & SYMPTOMS	DURATION OF SINGLE INFECTION	PERIODICITY OF FEVER	COMPLICATIONS
P.falciparum	MODERATE TO SEVERE	1 TO 2 YRS	DAILY OR ALTERNATE DAY	-HYPERPYREXIA -ANAEMIA, CNS, RENAL, HEPATIC, INTESTINAL, CEREBRAL MALARIA -SHOCK COLLAPSE -FATALITY
P.vivax	MILD TO MODERATE	3 TO 4 YRS	ALTERNATE DAY (BENIGN TERTIAN)	-ANAEMIA -EMACIATION -SPLENOMEGALY -HEPATOMEGALY
P.malariae	MILD	4 TO 30 YRS	EVERY 4TH DAY (QUARTAN)	-AS IN *P.vivax* -NEPHROSIS

C. Differential Diagnosis of Uncomplicated Malaria:

-History of the case: Physician should elicit detailed history of fever episode and presenting sign & symptoms.

-History of movement

-History of exposure to malaria is quite important.

Enquire if the patient has recently been travelling - where, when and for how long - strongly suspect malaria amongst those who have fever, anaemia and tender splenomegaly and who are from a malarious area or have recently visited a malarious area.

- History of recent blood transfusion: The physician should not forget to enquire history of recent blood transfusion from a fever case both ambulatory or indoor. The incubation period of malaria varies from case to case. The incubation period and severity of symptoms are also governed by the malaria immunity of individual developed during previous exposure to malaria in *P.vivax*. Successful invasion and fever manifestation occur even if 10 parasites are injected during blood transfusion. The incubation period is usually:-

- *P.falciparum*	-	9 to 14 days.
- *P.vivax*	-	12 to 17 days.
- *P.malariae*	-	18 to 40 days.

The regular succession of paroxysms and fever free intervals are quite suspicious and suggestive of malaria infection.

- Rapid remission of fever and other symptoms are characteristics of malaria.

The differential diagnosis has to be made from the following:-

1. Septic Conditions - Acute suppurative otitis media, Abscess, Cellulitis, etc.

- If there is daily rise of temperature before or in the early afternoon, suspect malaria.

- If the daily rise of temperature is in the late afternoon or evening, it is strongly suggestive of septic condition.

2. Viral Diseases

a. Infective Hepatitis

- Fever with jaundice - suspect malaria and rule out by microcopy for MP and other tests for infective hepatitis.

- Tender liver enlargement - suspect infective hepatitis.

- Van den Bergh reaction - direct in infective hepatitis, indirect in malaria.

b. Dengue

- Very severe generalised muscular pains, saddle back, seven days fever curve, slow pulse, lymphadenitis, rash.

- Marked leucopaenia, decreased platelets in children and no splenomegaly.

c. Sandfly Fever

- Severe orbital pain, conjunctival injection intense, photophobia, three to four days continuous fever.

- Relative and absolute diminution in neutrophils with relative increase and absolute increase in immature neutrophils. (also in Dengue)

- No splenomegaly, subjective complaints of melancholia and apathy may persist after dengue or sand fly fever but usually not after malaria attack.

d. Yellow Fever

- History of patient suggests visit to yellow fever area in recent past.

- No splenomegaly.

- Pulse stationary with rising temperature or falling with stationary temperature.

- Jaundice on third day, progressive, intense.

- Typical mucoid and black vomit about the fourth day.

3. Bacterial Diseases

a. Typhoid Fever

- Blood culture positive during first ten days of fever.

- Stool culture positive after tenth day with increasing frequency up to fourth or fifth week is diagnostic.

- Negative blood smears for malaria and lack of response to malaria therapy.

b. Relapsing Fever

- Sudden onset with splenomegaly and leucocytosis.

- Blood films reveal causative organism of relapsing fever.

- Typical relapsing fever curve and lack of response to antimalarial drugs.

c. Meningococcal Infection

- Signs of meningeal irritation.

- CSF slightly turbid.

d. Upper Respiratory Tract Infections and Urinary Tract Infections show typical sign & symptoms related to the system involved.

4. Helminthic Diseases

a. Early Filariasis

- Lymphadenitis with fever and sometimes enlarged lymph nodes are palpable.

- Involvement of genitalia in chronic cases. Some acute cases show epididymo-orchitis.

- Leucocytosis and eosinophilia.

- Splenomegaly and anaemia are not present even in the long standing patients.

- Peripheral blood smear reveals microfilaria.

b. Schistosomiasis

- In early stage - fever may be intermittent or quotidian.

- History of exposure may be elicited or suspected in cases reporting from endemic areas.

- Rash is typical.

- Eosinophilia very high.

- Serological tests may assist.

5. Protozoal Diseases

a. Kala-azar

- Spleen-enlargement, spongy or hard, bleeding gums, notable cachexia, extreme weakness, emaciation.

- Fever is continuous.

- Early and pronounced leucopoenia.

- Blood film, bone marrow/lymph node aspirate reveal *Leishmania donovani.*

b. Amoebic Abscess of Liver

- Hepatomegaly without splenomegaly, tender liver.

- Rigidity of right rectus muscle.

- High leucocytosis with relatively high polymorph count and no increase in monocytes.

- Quotidian sweating in the evening.

- Indirect haemagglutination test for amoeba is the specific test.

- X-Ray/Screening chest for liver abscess - helpful.

c. Trypnosomiasis

- Identification of Trypanosoma in blood, lymph node and CSF is diagnostic.

- Complement fixation test is also confirmatory.

- Increase of protein and mononuclear cells in CSF.

II. *P.malariae* INFECTION:

- Produces very mild clinical manifestations and fever has a periodicity of four days (Quartan malaria).

- Patient may have parasite in peripheral blood without fever. Untreated infection may last up to 30 years.

- Nephrosis has been reported in a few cases.

III. *P.falciparum* INFECTION:

A. Clinical Picture:

- Sequence of events in a fever episode is similar to that of *P.vivax*.

- Unlike *P.vivax* case, usually there is no feeling of well being after paroxysm.

- Fever is often high, irregular, intermittent, remittent/ continuous type.

- Headache and vomiting more common.

- Sweating is not a persistent feature.

- In hyper/holoendemic area, prolonged low grade parasitaemia of *P.falciparum* may result in gradual personality and psychological changes due to permanent damage of brain tissue.

- Mortality in patients after development of complications may be from 20% - 50% depending on time-lag between onset of disease and start of specific treatment.

B. Differential Diagnosis - General Considerations:

Some important but general considerations during differential diagnosis are:-

1. Sporadic

In time and space, usually a single case is reported from a locality or a village. This is true except for an area having fulminating epidemic of *P.falciparum* when a larger number of severe cases may be encountered.

2. Locality

The case is reported from an area known to be endemic for malaria. However, at times a person hailing from a non-endemic area may develop serious complications just after his return from malarious area.

3. Transmission

The case usually occurs during malaria transmission season, although a case can be encountered at any time during the year, but during non-transmission season very rare.

4. Age

No age group is exempted. However incidence is higher in non-immune infants and children.

5. Sex

Both sexes are equally vulnerable but **pregnant women are more prone to severe complications.**

6. Suppressive Chemotherapy

After discontinuation of suppressive treatment, (chemoprophylaxis), severe *P.falciparum* complications can occur within three weeks.

7. At any given time unusually large number of cases with symptoms showing massive & severe involvement of brain, intestines or any other internal organ from the same locality require careful differential diagnosis.

C. Complications of *P.falciparum* Malaria:

It has been estimated that 0.5 to 2% cases of *P.falciparum* in non-immune population may develop serious complications.

The direct complications due to *P.falciparum* infection are mentioned hereunder in order of frequency of presentation.

1. Hyperthermia
2. Anaemia
3. Hypoglycaemia

4. Dehydration

5. Pulmonary oedema

6. Cerebral malaria

7. Shock - general collapse-algid malaria

8. Gastro-intestinal manifestations

9. Acute renal failure

10. Haemolytic jaundice - liver damage

11. Black water fever, Haemoglobinuria.

12. Petechial Haemorrhages/intra-vascular coagulation.

Any of the above complications can occur in a patient(s) with lowered body resistance or immune status and should be suspected in case of :

i. An unexplained fever

ii. Pregnant women

iii. After child birth in post-partum period

iv. Accidents

v. Post operative period

vi. Malnutrition

vii. In association with acute or chronic infections, and

viii. Blood transfusion.

1. CEREBRAL MALARIA:

Clinical signs are those of a diffuse symmetrical encephalopathy:

- Eyes may remain open with an increasing stare or rarely photophobia.
- Dysconjugate eye movement.
- Oculogyric crisis.
- Deep stertorous breathing combined with decorticate (decerebrate) rigidity can be part of cerebral malaria syndrome. Sometimes this could also occur on account of hypoglycaemia.
- **Neck rigidity does not occur but mild stiffness of neck is not uncommon.**
- There are no signs of raised intracranial pressure and the CSF is clear.
- Reflexes: abdominal reflexes are invariably absent and planter responses are usually of extensor type.
- Retinal haemorrhages may be encountered in a few cases.
- Cerebral dysfunction - mental aberration, impaired consciousness, delirium.

Malaria should be first suspected in any unexplained fever in an endemic area, or in a person coming from an endemic area.

Differential Diagnosis

The patient with hyperpyrexia may go in a comatose condition or may develop coma soon after admission. **Coma is often unarousable** A physician should consider other causes of a cerebral episode while arriving at the final diagnosis, in all cases hypoglycaemic coma should be ruled out.

i. Heat Stroke:

- Generally occurs in summer season,
- History of exposure to heat,
- Hyperpyrexia,
- **Dehydration with dry and warm skin,**
- **Pronounced typical absence of sweating,**

During peak summer season with low humidity, cerebral malaria is a rare occurrence while heat stroke is more common.

The laboratory tests such as blood smear and CSF examination will be normal.

ii. Meningitis:

- **Neck rigidity**
- Gradual onset of symptoms and progressive deterioration
- History of possible infection.
- There may be several such cases from the same locality at the time of epidemic.
- **In cerebral malaria, no neck rigidity,CSF**

does not show changes while in meningitis typical neck rigidity is accompanied with changes in CSF.

- **Coccal Meningitis usually occurs in winter season**

- Confirm by CSF examination and blood culture.

iii. Viral Encephalitis:

- Occurs in epidemic form.

- Several cases with similar history and symptoms come from an area within a short period.

- **Fever, neck rigidity with typical headache and disturbance of consciousness are present.**

- **Usually the cases occur in post-monsoon season when cerebral malaria also occurs.**

- Confirm by TLC/DLC, CSF examination and if possible by isolation of virus.

iv. Cerebro-Vascular Episode:

- Sudden in origin.

- Indications of localised involvement of brain due to haemorrhage or thrombosis.

- Neck rigidity may or may not be present.

- **Isolated cases occur in a locality.**

- Cases can occur at any time of the year.

- **Higher age group.**

- Confirm by changes in CSF.

v. Hypertensive Encephalopathy:

- **Isolated single cases occur at any time of the year.**

- Past history of hypertension.

- **Uncontrolled hypertension prior to episode.**

- Cerebral symptoms vary from person to person.

- Often onset is sudden.

vi. Uraemic & Hepatic Coma :

- The history of chronic illness, with sign and symptoms of underlying disease, gradual onset and progressive deterioration of the case.

- **The sign & symptoms of renal or hepatic failure are present over a long period.**

- **Laboratory tests confirm the diagnosis.**

vii. Diabetic Coma (Hyper or Hypoglycaemic)

- **Usually no rise of body temperature**

- **Cases are usually isolated, single from a locality.**

- History of diabetes and treatment with anti-diabetic drugs.

- Gradual or sudden onset.

- Progressively the condition deteriorates.

- Confirm by urine and blood sugar examinations. Urine examination shows sugar or no sugar and ketone bodies, blood sugar levels are high or low as the case may be.

- **Laboratory findings confirm the diagnosis.**

viii. Epilepsy:

- In children, there will be previous history of similar attacks.

ix. Other Clinical Entities:

Other diseases to be excluded are:-

- Typhoid encephalopathy.
- Gram-negative septicaemia.
- Brain abscess.
- Narcotic poisoning.

Table- 4.2 : Changes in Cerebrospinal Fluid in Cerebral Malaria and other Diseases considered for Differential Diagnosis*

	NORMAL VALUES	MALARIA	MENINGITIS MENINGO COCCAL	TUBER-CULAR	OTHER COCCAL	JAPANESE B. ENCE-PHALITIS	SUB ANCHNOID HAEMORR-HAGE	HYPERTEN-SIVE ENCEPHA-LOPATHY	HEPATIC ENCEPHA-LOPATHY
Pressure	50 to 180 mm H_{20}	Normal to ++	± to +	± to +	± to +	± to +	+ to ++	Normal to +	Normal
Character	clear and colourless	Normal	Normal or xentho-chromic	clear	Normal or xentho-chromic	Normal	Bloody or xentho-chromic	Normal	Normal or xentho-chromic
Cells	$1\text{-}5/mm^3$								
-Polys	-	-	+++	-	+++	-	+ to +++	Normal	-
-lymphos	1-5/mm3	+	-	+++	-	++	+ to +++	Normal	+ to ++
Protein	15-40 mg/L								
-Globulin		+ to ++	+++	++	+++	± to +	± to +	± to +	± to +
-Albumin		++ to +++	+++	++	+++	+ to ++	± to ++	+ to ++	+ to ++
Sugar	40-70 mg/L	Normal or +	- to ±	± to +	- to ±	Normal	Normal	Normal	Normal
Chlorides	720to750mg/L 116 to122Meq/L	Normal	±	- to ±	±	Normal	Normal	Normal	Normal
Micro-organisms	Nil	Nil	± to +	±	± to +	Nil	Nil	Nil	Nil

2. ACUTE RENAL FAILURE:

According to some studies acute renal failure occurs in approximately 10% of cerebral malaria cases. It is a reversible process but in some - mainly adults, it leads to acute tubular necrosis and mortality.

The exact precipitating factors of acute renal failure in *P.falciparum* infection are not known. The renal anoxia due to impaired intrarenal blood flow may be the main reason. **The renal failure is indicated when 24 hour urinary output drops to 400 cc or below and serum creatinine more than 3.0 mg / dl fails to improve after rehydration.**

In such condition, blood urea, serum creatinine and plasma potassium are raised, specific gravity of urine is about 1.00 or less. On the other hand, in case of heat stroke, a concentrated urine with normal microscopic appearance is due to dehydration.

In chronic cases of *P.malariae* kidney damage develops slowly over a period of time. The underlying pathological changes associated with nephrotic syndrome are focal hyalinising lesion and segmental endothelial cell proliferation. The thickening of capillary wall of basal membrane is due to deposition of antigen-antibody complex at this site.

3. PULMONARY OEDEMA:

- Known to occur in *P.falciparum* malaria late in course but develops rapidly due to massive transudation of fluid in the lung alveoli.

- A variety of associated causes which trigger this condition are:

- Over hydration
- Pregnancy
- Cerebral malaria
- High parasitaemia (Density of asexual forms of Pf exceeds 5% of erythrocytes in peripheral blood)
- Hypotension
- Acidosis
- Uraemia.

- If not treated promptly, it produces high mortality due to resultant hypoxia, dyspnoea and strain on cardio-vascular system. The sign & symptoms are:-

- Pulmonary distress such as shortness of breath, cyanosis, shallow rapid breathing, increase in respiratory rate.
- Rapid pulse.
- Sometimes blood tinged sputum.
- Basal crepitations.

4. GASTRO-INTESTINAL INVOLVEMENT:

The symptoms arise because of massive involvement of intestinal vascular bed leading to necrosis of intestinal mucosa and its congestion.

The important cardinal symptoms represent acute diarrhoea with shock such as:-

- Low blood pressure, high pulse rate
- Hyperpyrexia but later in terminal cases hypothermia
- Anorexia, nausea, vomiting, abdominal pain
- Diarrhoea with bloody stools, not containing any infecting pathogen and differ from that in cholera as the stools are blood stained.
- Pronounced dehydration
- It may mimic any abdominal condition such as pancreatitis, biliary colic, typhoid, acute appendicitis.

The diagnosis is confirmed by blood examination for M.P.

5. ALGID MALARIA:

The patient comes with typical sign and symptoms of shock in a collapsed condition. His clinical picture shows:

- Cold, clammy skin, extremities are also cold

- Rectal temperature high, although oral temperature may be low

- Loss of skin elasticity

- Lips, nails, etc., cyanotic, with shallow laboured breathing, pulse thin, fast, with low B.P.

- P.C.V. high

- Blood slide positive for *P.falciparum*

The patient is in shock and the management is generally initiated by administration of antimalarials and supportive treatment for management of shock.

6. HAEMOGLOBINURIA AND BLACK WATER FEVER:

The name of this entity arises from the fact that in *P.falciparum* infection some cases pass black or smoky urine. It is believed that the condition is precipitated usually in non-immune cases treated with non-therapeutic dosages of Quinine, which are usually taken irregularly as a suppressive. It is related to Glucose-6-Phosphate dehydrogenase deficiency status. Sometimes it may be a part of auto-immune reaction. There is massive haemolysis of red blood cells. This syndrome is not seen in infections with other species of *Plasmodium*. It produces very high mortality, if not managed properly. The cardinal clinical features are:

- **High degree of anaemia, RBC count as low as 1 mill/cmm.**

- Low Hb levels, cases up to 10% Hb have been reported.

- **Urine dark brown due to methaemoglobin or red when oxyhaemoglobin is present. The bile, albumin, hyaline and granular deposits, sometimes RBC casts may be present in urine.**

- Moderate to high parasite count in peripheral blood smear.

For differential diagnosis all other conditions producing haemoglobinuria should be considered.

7. LIVER DAMAGE - HAEMOLYTIC JAUNDICE:

The liver damage is very rare in *P.falciparum* infection, occurs due to excessive haemolysis, sudden load is sometimes so high that liver is not able to cope with it. On clinical examination:-

- **Liver is enlarged, soft and tender.**

- **Moderate to severe jaundice of haemolytic nature.**

- The condition usually clears up when antimalarials are given and parasitaemia as well as haemolysis are controlled. As the condition is usually associated with other severe manifestations of *P.falciparum* infection, its management forms a part of other complications.

8. ANAEMIA:

Usually severe anaemia in *P.falciparum* infection due to rapid and pronounced haemolysis, in acute cases it is normocytic and normochromic. The RBC destruction is due to two reasons, destruction of parasitised RBC which in untreated severe cases may be massive, secondly the normal RBCs are destroyed due to toxins liberated by the parasite.

Thus the quantum of haemolysis is never directly proportional to parasite density levels in the blood. Sudden reduction in haemoglobin, similar to profuse loss of blood, is responsible for shock.

The entity rarely causes mortality, if proper treatment and management are carried out.

However, in more prolonged infections the anaemia is megaloblastic and hypochromic type.

Severe anaemia when haematocrit less than 20% or haemoglobin less than 7.0 gm per dl.

9. HYPOGLYCAEMIA: (BLOOD GLUCOSE LESS THAN 40 MG/DL)

- **It is a common complication in severe *P.falciparum* infection.**

- **It is a serious complication in pregnancy and children or**

- **In those who have recently delivered/those with severe infection.**

- **Quinine in therapeutic doses can cause hypoglycaemia on account of excessive Insulin release.**

- It is to be treated as a medical emergency with I.V. 50% glucose while treatment is given with Quinine. Convulsions are not uncommon.

- **Milder symptoms are**

- anxiety	- breathlessness
- confusion	- oliguria
- sweating	- tachycardia
- feeling of cold	- headache.

10. DEHYDRATION:

It is the most common complication in severe malaria infections with *P.falciparum* and other malaria parasite species. On account of hyperthermia and hyperventilation this complication is more often encountered in vulnerable age groups i.e. infants or young children.

The patient presents with:-

- Parched lips. The lips are dry and caked with mucus.

- Pinched appearances due to extensive loss of water, face of the patient especially in infants and young children gives sunken appearance.

- Skin is dry, hot sometimes wrinkled. There is loss of elasticity of the skin.

- The patient presents with unquenchable thirst.

- Oliguria or anurea is quite often present.

- The condition is serious in younger age group and requires immediate attention and proper management.

***P.falciparum* Infection in Infants and Children:**

- All severe complications described above are more acute in case of infants and children due to their low immunity status.

- In early months of life manifestations are mild with low grade parasitaemia (10%) because of passive immunity.

- Parasitaemia increases with age.

- In hyper endemic areas mortality rate is highest during the first two years of life.

- Clinical presentation shows continuous and very high fever.

- Fever is quite often associated with cerebral symptoms of confusion and convulsions especially at the age of 6 months to 5 years.

- The associated gastro-intestinal upset brings about persistent vomiting and diarrhoea.

Renal failure is unusual.

In highly malaria endemic areas *P.falciparum* infection of local children during the first five years of life can cause fatal illness.

The parasitological and other laboratory findings are same as described earlier. The management of case is more difficult but prompt antimalarial treatment with administration of oral or parenteral therapy along with supportive treatment is required. This would increase chances of recovery.

Table- 4.3: Differences between Severe *falciparum* Malaria in Adults and Children:

Sign and Symptoms	Adults	Children
Cough	Uncommon early symptom	Common early symptom
Convulsions	Indicate cerebral involvement or hypoglycaemia	May indicate cerebral involvement or hypoglycaemia, but may be a nonspecific consequence of fever.
Duration of symptoms before features of severity develop	Commonly several days	Usually 1-2 days only
Jaundice	Common	Uncommon
Time from start of treatment to resolution of coma in cerebral malaria.	Usually 2-4 days	Usually 1-2 days
Hypoglycaemia	Uncommon, usually Quinine-induced (especially in pregnancy) with hyperinsulinaemia. Sometimes pretreatment with low plasma insulin.	Common, usually pretreatment, with proportionate decreased circulating insulin.
Pulmonary oedema	Common	Rare
Susceptibility toxicity of antimalarials	See above Quinine induced hypoglycaemia in adults.	**More liable than adult to suffer circulatory collapse after parenteral Chloroquine if given rapidly.**
Renal failure	Common	Rare
Neurological sequelae	Uncommon	Occur in about 10% of cases.
Cerebro-spinal fluid (CSF)		
-Pressure	Normal	Variable
-Changes	Normal	Normal

Malaria in Pregnancy

- Although all other manifestations of malaria are more or less same in a pregnant woman, the most important complication arises because of the fact that the placenta is heavily loaded with *P.falciparum* blood stages and their concentration in placenta is higher than in any other organ due to preferential parasitic sequestration.

- This pathology results in decreased blood flow in placenta and consequently foetal anoxemia occurs. Foetal distress causes intra-uterine death with miscarriage or abortion. In case, the above complication does not arise, then due to lowered oxygen tension and flow of nutrients from placenta to foetus, the foetal development is retarded and low birth weight babies are common in malarious areas. Malaria in pregnant women is associated with high maternal and foetal mortality.

- Other common complications in pregnant women are renal failure and eclampsia, acute pulmonary oedema, hypoglycaemia and anaemia.

- In hyperendemic areas, in a primigravida there is increased parasitaemia and serious effects of malaria when compared to multigravida.

To arrive at correct and quick diagnosis the pathological investigation should start with examination of peripheral blood for malaria parasite.

Some of the investigations which should be carried out are:

i. Blood pressure

ii. Microscopic examination of peripheral blood smear for M.P. - To repeat every 6 - 8 hours as long as slide is negative but there is strong clinical and other epidemiological evidence supporting clinical diagnosis of malaria. When slide is found positive, do parasite count.

Note: In rare cases the peripheral blood smear may be initially negative because all parasites are in late trophozoite/schizont stage and are sequestrated in capillaries of internal organs. They will come to peripheral circulation at a later stage as rings and can be recognised microscopically. The process may take 6 to 12 hours.

iii. Total RBC count

iv. HB %

v. Total WBC and differential count

vi. ESR

vii. C.S.F. examination.

viii. P.C.V.

ix. Blood Chemistry - urea, serum bilirubin, sugar, electrolytes, creatinine.

x. Urine examination.

xi. Viral and bacteriological studies.

Other biochemical or pathological tests, if required, may be carried out during the course of treatment to see the progress of the case.

BLOOD PICTURE IN MALARIA

RBCs:

Total RBC count reduced, Poikilocytosis, Polychromasia, Anisocytosis.

In Acute Attack:

Normochromic, Normocytic anaemia

In Chronic Cases:

Reticulocyte count increases, rarely nucleated RBCs are present in severe anaemia.

Haemoglobin:

Rapid fall - a fall of 0.5 to 1 gm. per day in high parasite densities during acute attack, as low as 10% Hb levels have been recorded in cases with massive haemolysis in Black Water Fever.

Packed Cell Volume:

Low, sometimes as low as 20%.

Platelets:

Thrombocytopenia of varying degrees.

WBCs:

Early Stages:

Leucocytosis of varying degrees.

Long Standing Chronic Cases:

Leucopenia.

Plasma Proteins:

Reduced.

Albumin/Globulin Ratio:

Altered.

Erythrocyte Sedimentation Rate:

Increased, more pronounced in acute cases and severe anaemia.

Serum Bilirubin:

Raised.

Blood Sugar:

Variable, sometimes raised during hyperpyrexia, **low in acute severe cases with *P.falciparum* infections.**

Blood Urea:

Raised in renal dysfunction.

Serum Creatinine:

Increased in renal failure.

Electrolytes:

Electrolyte imbalance with acidosis: - Sodium/Potassium ratio altered.

URINARY CHANGES IN MALARIA

In acute *P.falciparum* infection:

1. Urine output: low in case of acute renal failure (less than 400 cc per day).

2. Specific gravity: 1.00 or less.

3. Albumin: present in traces.

4. Urobilinogen: high.

5. Sodium/Potassium ratio: altered.

6. RBCs: occasionally present in low numbers.

7. Casts: hyaline and granular present.

8. Haemoglobin - present largely as oxyhaemoglobin and methaemoglobin in complicated malaria such as Black Water Fever.

Any one of the above abnormalities may be present in a malaria case, but urinary changes in acute *P.vivax* or *P.malariae* infections are rare.

ERRORS IN DIAGNOSIS

- **Failure to examine blood smear:** The commonest error in diagnosis of malaria is the failure to examine blood film in a fever case. The fever in malaria may not show typical stages of malaria paroxysm. The fever may not be very high. Sometimes it is accompanied by other sign & symptoms which may not be strong enough to suggest clinical diagnosis of malaria. However, it is imperative that all fever cases should be subjected to microscopic blood examination for malaria parasite to exclude possibility of malaria infection.

- **Failure to take history of movement:** In non-malarious areas, the physician may forget to take the history of movement of the patient and thus miss the clinical diagnosis of malaria. The incubation period in *Plasmodium infection* is usually from 9 to 28 days. Therefore, unless history of movement is taken in a fever case, it may not be possible to exclude malaria infection by any degree of certainty because prior to incubation period, the patient might have visited endemic areas during the transmission season. A treating physician should always elicit the history of movement of the patient during the fortnight preceding the first fever episode.

- **Failure to realise severity of the disease:** This lapse may result in development of further complications and increase the chances of mortality in a patient. Sometimes even in a patient with low grade temperature, the parasitaemia levels may be high as is seen in algid malaria due to

P.falciparum infection. In these cases, rectal temperature is usually high and will point towards severity of the disease. Therefore, in malarious areas, where *P.falciparum* infections predominate, a physician should be careful to consider all sign & symptoms and during physical examination should record rectal temperature so as not to miss the severity of fever. He should very carefully conduct systemic examination of the patient. He should also note whether there is amelioration of symptoms after medication or these symptoms continue or their severity increases.

Errors in Microscopic Diagnosis

These errors arise due to inefficiency of laboratory technicians, faulty collection of blood smears and failure to examine requisite number of fields in thick smears of suspected malaria cases. The errors may also arise due to poor staining of blood smears and artefacts therein.

Faulty Differential Diagnosis

If a treating physician does not take all precautions and fails to consider all aspects of differential diagnosis of malaria, he is likely to miss a malaria case.

On account of the extensive malaria control operations undertaken all over the country, clinical presentation of malaria case is modified in different paradigms of malaria. In areas where malaria transmission is interrupted or at a low level, the non-immune population will present with clinical sign & symptoms with wide variations depending on the immune status of the patient, on account of the previous exposure to malaria or general innate immunity levels of the person which determine the response of individual to parasitic infection. These patients present mixed clinical picture, while in other non-immune persons specially children symptoms are more pronounced. In hyper endemic areas, the clinical picture in adults is more or less uniform due to frequent exposure to malaria. But in infants and young children up to 5 years age, the sign & symptoms vary in the intensity. Therefore, a practising physician should update his knowledge of malaria endemicity in the locality.

The Directorate of NMEP has laid down some general principles for clinical diagnosis of malaria case which are not very exhaustive but may be useful to a practising physician. However, no clear-cut guidelines can be laid down for proceeding with the differential diagnosis but a physician after considering various aspects of the presenting fever episode in a patient should carry out the laboratory examination to exclude other diseases. The guidelines given by the NMEP are reproduced below:-

Suspected Malaria Cases

All fever cases unless proved negative for malaria parasite on microscopy.

Probable Malaria Cases: clinically diagnosed by Medical Officers

Fever cases without the following associated symptoms and not subjected to microscopic examination may be suspected and reported separately as clinical malaria cases:

1. Cough - Acute respiratory infections
2. Cold with running nose.
3. Skin rash suggestive of eruptive illness.
4. Burning micturition.
5. Skin infection e.g. boils, abscess, infected wounds.
6. Painful swelling of joints.
7. Ear discharge.
8. Fever in Infective Hepatitis.
9. Non-endemic areas splenomegaly with irregular fever, skin pigmentation suggestive of Kala-azar.
10. Lymphangitis and lymphadenitis in filaria endemic areas.

Seriously Sick Malaria Cases

The seriously sick malaria cases are those who present with the following sign & symptoms:

- Cerebral malaria - Case of unarousable coma not attributable to any other cause in a patient with *P.falciparum* infection.

Other cases with hyperpyrexia, convulsions, severe anaemia, pregnancy with fever, pulmonary oedema in *P.falciparum* infection, hyper parasitaemia and malaria haemoglobinuria.

Deaths due to Malaria

- Malaria deaths are only due to *P.falciparum* infection.
- Deaths are very common in cerebral malaria cases and other serious complications in *P.falciparum* infection.
- If any fever case having sign & symptoms cited above dies without microscopic confirmation, the death can be attributed to probable infection with malaria parasite.

Confirmed Malaria Death

- Death of microscopically confirmed *P.falciparum* infected patient due to any of the complications mentioned above.

Missed Hypoglycaemia

One of the serious complications of *P.falciparum* malaria is hypoglycaemia. During acute stage and hyperpyrexia, sometimes the blood sugar levels may be high but usually *P.falciparum* malaria precipitates hypoglycaemia. It may present in a more severe form in diabetic patients, children and infants. Therefore, laboratory investigations for blood sugar level are a must in a patient presenting with acute malaria, especially in complicated malaria cases, so that immediate steps may be taken to correct hypoglycaemia.

SECTION - 2
TREATMENT AND MANAGEMENT OF MALARIA PATIENTS

INTRODUCTION

The case management in malaria comprises of three aspects:-

1. Specific treatment with antimalarials.
2. Supportive symptomatic treatment.
3. Specialised nursing care in severe and complicated malaria cases.

If clinical sign & symptoms indicate strong evidence of malaria, the physician should proceed with microscopic confirmation of malaria parasite, blood picture, haemoglobin percentage and other tests. However, he should not wait for microscopic confirmation and start the treatment immediately.

Before going into the specific aspects of treatment and management of malaria cases, it is necessary to familiarise with **different terminologies used in treatment of malaria**

Blood Schizonticidal Drugs

- Drugs which act on asexual forms of malaria parasite i.e. ring, trophozoite, schizont.

Tissues Schizonticidal Drugs

- Drugs which act on asexual forms of malaria parasite in the liver i.e. the primary tissue schizont of pre-erythrocytic forms in liver.

- Hypnozoites or late tissue schizonts are affected by Primaquine.

Gametocytocidal Drugs

- Drugs which act on sexual forms of malaria parasite.

Sporontocidal Drugs

- Drugs when given to infected person prevent development of parasite in the mosquito.

Terminology used for Treatment Schedules of Malaria

Suppressive Treatment

- It prevents appearance of clinical symptoms and parasitaemia by early destruction of erythrocytic stages of parasite. It does not necessarily prevent or eliminate malaria infection. Patent parasitaemia and clinical symptoms may sometimes develop when suppressive treatment is withdrawn.

Radical Treatment

- It aims at achieving complete parasitic cure and in case of *P.vivax* preventing relapses by destroying hypnozoites which is achieved by administration of proper antimalarial like Primaquine, which has effect on hypnozoites. The radical treatment acts on gametocytes also. This prevents further transmission of malaria from an infected person.

Presumptive Treatment

- Presumptive treatment is administered to all suspected cases of malaria i.e. all fever cases in the locality. Such a treatment consists of a single/multiple doses of schizonticidal drug like Chloroquine. The objective is to achieve remission of symptoms till the diagnosis is confirmed microscopically and radical treatment can be administered.

Mass Drug Administration

- Usually it is a part of malaria control operations where all fever cases or general population or a particular group of persons of the locality such as children, pregnant women and migratory labour are given combination of schizonticidal and gametocytocidal drugs to achieve remission of parasitaemia and liquidation of gametocytes.

Clinical Cure

- For clinical cure, schizonticidal drugs are administered to achieve remission of clinical symptoms and parasitaemia.

Chemoprophylaxis

- It is aimed at prevention of disease manifestations in the individuals. It does not prevent infection with malaria parasite because no antimalarial has action on sporozoites, (absolute prophylaxis) but causal prophylactic drug given in repeated doses at weekly interval prevents appearance of clinical sign & symptoms and parasitaemia in the person.

Before taking up management of malaria cases, some general remarks about use of antimalarials-their action, adverse reactions, etc. are given below:-

MANAGEMENT OF UNCOMPLICATED MALARIA

Physician's Options

Out of a large number of antimalarial compounds available for treatment of malaria, the physician while treating a malaria case has to decide the drug of choice. The options available are decided on:-

i. The route of administration - oral, intramuscular, intravenous,

ii. Rapidity of absorption from the route of administration,

iii. Time taken to achieve therapeutically effective blood concentration,

iv. Half life of the drug,

v. Excretion time/rate,

vi. Adverse reactions such as idiosyncrasy, chronic toxicity on prolonged use,

vii. Contraindications,

viii. Precautions to be observed as well as the efficacy of antidotes available for treatment of acute or chronic toxicity and

ix. Nursing care required if adverse reactions are encountered.

General Rules of Antimalarial Therapy

Before the details regarding the mode of action, dosage, etc. of different antimalarials are discussed, it is necessary to lay down some ground rules for use of antimalarials. These rules will help the physician in choosing appropriate treatment schedule for a patient suffering from malaria.

1. Oral administration of antimalarials should be preferred in all cases who can swallow and retain antimalarial compounds, as most antimalarials are absorbed rapidly.

2. Intravenous antimalarials like Quinine or Artemisinin should be used in comatose patients or patients who cannot retain antimalarials administered orally, usually due to gastro-intestinal irritation and vomit out.

3. An antimalarial with good chemo-therapeutic index (difference between clinically effective and toxic dosage) should be chosen for oral and parenteral administration.

4. Chloroquine is the drug of choice for treatment of *P.vivax, P.malariae* and *P.falciparum* malaria parasites.

5. Only in cases where infection with *P.falciparum* strain resistant to Chloroquine is suspected, other antimalarials should be used.

a. In ambulatory cases of infections with *P.falciparum* resistant strain without complications, long acting Sulfa+Pyrimethamine combination is the drug of choice.

b. In severe and complicated malaria, intravenous Quinine should be administered.

6. Internationally accepted dosage should be strictly adhered to so that future complications and toxic manifestations are avoided.

7. While administering the intravenous Quinine, patients should be carefully monitored for hypoglycaemic crisis and cardio-vascular complications. The arrangements should be made for appropriate investigations and suitable supportive treatment.

In uncomplicated malaria, the treatment is directed towards achieving clinical and parasitological cure by administration of oral Chloroquine phosphate in a single dose of 10 mg

per kg body weight. In cases microscopically confirmed to be suffering from *P.falciparum* infection, in areas where *P.falciparum* resistance or refractory strains to Chloroquine are present, in the first instance, oral Chloroquine is still the drug of choice and is given in three divided doses, i.e. on first and second day @ 10 mg per kg body weight and on the third day a dose of 5 mg per kg/body weight is administered. Usually the treatment with Chloroquine is adequate for achieving parasitological cure almost all over the country. But in areas where *P.falciparum* resistant strains are present and a *P.falciparum* case fails to respond to Chloroquine, a single dose of 1.5 gm of long acting Sulfa combination with 75 mg Pyrimethamine is administered.

Management of Associated Sign & Symptoms

Hyperthermia

To control hyperthermia, hydrotherapy is recommended with tepid water sponging of the face and limbs. If the temperature is above 103° F, the sponging is to be continued till temperature is brought down to 101° F. In cases of severe hyperthermia, the patient can be covered with bedsheets soaked in water and put under a fan, till the temperature is brought down to 101° F. It is usually beneficial if the patient is kept in an air-conditioned or air cooled room with adequate humidity which prevents rapid loss of fluid from the body. Paracetamol is the drug of choice given at the rate of 5 mg / kg body weight orally or if needed parenterally in suitable divided doses.

Dehydration

To combat dehydration, intravenous fluid, saline or glucose is required. The intravenous infusion of glucose is more appropriate for *P.falciparum* infection on account of the danger of hypoglycaemia in this infection. It is necessary to maintain slightly negative fluid balance because of the danger of pulmonary congestion which is quite frequently observed in malaria infection especially in case of *P.falciparum*.

Management of Convulsions

In the case of uncomplicated malaria, due to hyperthermia, infants and young children may develop convulsions which are managed by intramuscular or intravenous Diazepam in the dose of 0.15 mg per kg body weight. Diazepam can be administered at 8 hourly interval till convulsions are controlled.

Management of Disorientation

In young children, the hyperpyrexia sometimes results in disorientation. It can be managed by bringing down hyperpyrexia. Administration of tranquilisers is usually not necessary.

Monitoring of urinary output is necessary in case of malaria episode and a close watch should be kept on fluid intake and output.

A complete parasitological cure is achieved after administration of radical treatment to the patient which should include Primaquine in appropriate dosage. The dosage of Primaquine and other antimalarials is given in page 83 and 84.

Correction of Anaemia

As most cases of malaria are anaemic to begin with or develop anaemia during the course of infection on account of rapid destruction of RBCs and loss of haemoglobin, the treatment for anaemia should be simultaneously instituted with oral iron and folic acid in appropriate dosage. However, if haemoglobin is less than 7 gm/dl, it is beneficial to give blood transfusion.

Specific Treatment

Commonly marketed and extensively used antimalarials in India have been mentioned in the previous section.

There are other antimalarials which were used earlier but are no longer utilised. These drugs are: (1) Mepacrine, Atebrine, (2) Proguanil, Chlorproguanil, Cycloguanil, (3) Pamaquine, Quinocide, Plasmochin, (4) Dapsone, (5) Sulfonamides. These drugs are more toxic and their action is comparatively poorer as compared to drugs now recommended.

New Antimalarial Drugs

New antimalarials which are found to be very effective in treatment of malaria but are not currently marketed in India are:- (1) Mefloquine (2) Qinghaosu derivatives (3) Mefloquine

(2) Qinghaosu derivatives (3) Mefloquine combination with long acting Sulfa. (4) Halofantrine.

Some General Remarks About Antimalarials

Quinine in dosages prescribed for treatment of malaria does not induce abortion or miscarriage in pregnant women. Risk of abortion is higher in untreated cases.

Chloroquine resistant cases allergic to Sulfa drugs are to be treated with quinine or a combination of quinine and tetracycline.

Long acting Sulfa and pyrimethamine combination has very little effect on *P.vivax* and will not give clinical relief in such cases but it is the drug of choice for oral administration in infection with Chloroquine resistant strain of *P.falciparum*, its action is slow.

Prolonged administration of long acting Sulfa combination can produce Stevens-Johnson syndrome, agranulocytosis, aplastic anaemia.

These drugs are not suitable for prolonged suppressive treatment.

Their dosage schedule should be followed strictly.

They should be given to infants and pregnant women with caution.

There is higher risk of death on account of prolonged use of Sulfa combination as suppressive/prophylactic than that with *P.falciparum* infection provided the case is detected and treated in time.

Chloroquine, Primaquine or Pyrimethamine should never be given on empty stomach.

Patients having gastro-intestinal upset or those who cannot take or retain oral drugs should be given parenteral antimalarials, even if they are conscious.

During administration of Primaquine, look for acute toxicity - cyanosis and smoky urine.

If present:

Stop the drug.

Observe the case.

Transfer serious cases to hospital.

After administration of Primaquine, gametocytes may be seen for a few days in peripheral circulation but they are no longer infective to mosquitoes as they become non-fertile.

Primaquine should never be given to pregnant women or infants.

I. *P.falciparum* INFECTION

There is a direct relationship between case fatality and time lag between onset of attack and starting of specific treatment, especially in cerebral malaria.

Based on results of several studies, it is estimated that only 0.5 to 2% of *P.falciparum* cases develop serious complications.

In properly managed and treated patients, fatality rate of cases with serious complications are less than 20%.

To reduce period of morbidity and prevent mortality in clinically diagnosed cases, administration of specific and most suitable antimalarial should be started immediately without waiting for laboratory report. Laboratory confirmation may follow.

Treatment of a microscopically confirmed case of *P.falciparum* infection:

1. Patient who can ingest and retain oral dosage

a. In areas with Chloroquine sensitive strain:

Chloroquine (base) 1500 mg	600 mg first day 600 mg second day 300 mg third day

plus

If other complications are not present and haemoglobin is above 7-8 gms. a single dose of Primaquine 45 mg (0.75 mg per kg/b.w) is given on first day for its gametocytocidal action.

b. Areas with > 25% R I and R II incidence of Chloroquine resistant strain, the drug of choice and its schedule is:-

Long acting Sulfa - 1.5 gm + Pyrimethamine - 75 mg	i.e. 3 tablets as a single dose + 45 mg. Primaquine

(usually Primaquine is given on next day and not along with long acting Sulfa)

Note:-

The information on Chloroquine resistance areas keeps on changing. The latest information can be obtained from the office of the Regional Director, Regional Office for Health & Family Welfare and Directorate of National Malaria Eradication Programme.

2. Semiconscious or comatose patients of severe *P.falciparum* infections

Quinine should be given well diluted and slowly by I.V. Infusion. It is the drug of choice for pregnant women and infants

a. Quinine I.V. 10 mg/kg body wt. (600 mg), 8 hourly, (total 24 hour intake should not exceed 1.8 gms in an adult) till the patient regains consciousness and is able to take drugs orally. Oral Quinine 600 mg TDS is to be continued for seven to ten days. When adequate facilities for management of complications arising out of Quinine toxicity are available a loading dose of Quinine dihydrochloride 20 mg per kg body weight as infusion is given, and it should be well diluted with 500 ml of 5 per cent glucose. Infusion is given over a period of 5 hours (2 ml per minute). If no I.V. facility is available, deep intramuscular dose of 10 mg per kg body wt. is given 8 hourly. I.M. injections produce complications which, sometimes in the long run, are crippling if proper precautions are not taken.

b. Chloroquine

Chloroquine is not well tolerated specially by infants or young children, I.M. I.V. injection should not be given. In a patient of any age it may produce low blood pressure, sudden collapse, with high mortality.

Parenteral administration of Chloroquine is more hazardous than parenteral administration of quinine and is not recommended because of adverse reactions causing fall in blood pressure and cardiac arrhythmias.

In severe malaria cases I.M. antimalarial injection should not be given due to faulty peripheral circulation and erratic absorption of drug.

However, if Quinine is not available and only Chloroquine I.V. preparation is available, it is given in doses of 3.5 mg/kg body wt 8 hourly slowly in isotonic fluid. Total 24 hour dose should not exceed 600 mg base (up to 10 mg/kg body weight). Dose of Chloroquine I.M. is 5 mg per kg body wt.

Management of other Sign & Symptoms:

i. Hyperpyrexia:-(Rectal Temperature above 39° C).

a. Tepid sponging

b. If the temperature is 39° C or above, remove patient's clothes and cover him with towel or sheet soaked in tepid water and keep him under the fan.

c. Keep patient in an air-conditioned room, if possible.

d. Paracetamol: 5 mg kg/body wt parenteral administration if required.

ii. Dehydration :-

Glucose saline I.V., measure urine output, **maintain slightly negative fluid balance to avoid pulmonary complications**

iii. Acute renal failure with Anurea or Oligurea and Black Water Fever

It must be managed with proper biochemical examination of blood, serum electrolytes and E.C.G., etc.

a. Dextran with glucose saline I.V. to correct dehydration - If this fails to induce urine secretion and output remains less than 60 cc per hour, **give**:-

b. Furosemide 20 mg or as required, up to 500 mg I.V. or I.M. as considered appropriate.

c. Constantly keep watch on urinary output

d. If no improvement, **dialysis**. It should not be delayed and treating physician may take quick decision. It may require haemodialysis or peritoneal dialysis.

e. Keep watch on serum creatinine, blood urea and serum potassium levels.

f. Alkalinise the urine if haemoglobinuria.

g. Maintain diet control and restrict protein

intake to 20 to 30 gm per day.

iv. Hyperkaliemia :- Serum potassium should be kept below 5 mg/Lit.

a. 20 units insulin with 50 gm glucose, repeat as required.

b. Oral administration of exchange resin such as calcium zerocarb.

c. I.V. calcium gluconate 10 to 20 cc repeated as required.

v. Hypokaliemia :- Occurs with excessive diuresis after recovery in renal failure.

10 cc potassium chloride in 24 hours or equivalent.

vi. Pulmonary Oedema:- Arterial blood gases are monitored if the patient shows evidence of cyanosis, pneumonia or hyperventilation.

a. Prop up at 45 ^{0}

b. Oxygen

c. Keep careful watch on fluid balance

d. Monitor central venous pressure

e. Venesect 250 ml blood into donor bag to be used later on

f. Give diuretic

vii. Gastro Intestinal complications :-

a. I.V. fluids.

b. For vomiting: Chlorpromazine I.V. or I.M. as required.

viii. Bleeding (pulmonary oedema or gastro-intestinal complications) :-

a. Parenteral vit K, dosage to be regulated depending on patient's condition.

b. Fresh whole blood transfusion.

ix. Jaundice & Liver damage

a. I.V. Glucose

b. Restrict fats

c. K and Vit B complex supplement

d. Bed rest

x. Shock

a. I.V. Plasma expanders

b. Corticosteroids : if condition indicates, use up to 100 mg 8 hourly

c. Dopamine drip

xi. Anaemia (P.C.V. 20%, Hb less than 7 gm)

- If associated with high parasitaemia

a. Whole fresh blood transfusion

b. Pack cell transfusion

c. After acute condition is controlled, use iron folic acid supplement.

xii. Convulsions

- Mostly due to hyperpyrexia

- Specially in children in both *P.vivax* and *P.falciparum* infections.

a. Diazepam (0.2 mg per kg body wt) I.M./ I.V., 8 hourly dosage to be regulated by patient's response or Phentoin Sodium 5 mg per kg. body wt slow I.V. infusion over 15-20 minutes

b. Prophylactic phenobarb 5 to 10 mg per kg body wt

xiii. Hypoglycaemia

- I.V. glucose 50% (up to 1 ml. per kg body weight) followed by 5 to 10% I.V. drip. Keep constant watch on blood sugar levels.

xiv. Hyperparasitaemia (Parasitised RBCs 10% or above)

- Exchange transfusion

NURSING CARE

Nursed on their side as vomiting is common. Turned regularly at 2 hour interval or semi-prone.

1. Keep air passage clean and clear.

2. Give Oxygen if signs of air hunger.

3. Prop up patient at 45^0 if hypostatic lung congestion.

4. Record 2 hourly temperature (rectal), pulse and blood pressure.

5. Tepid sponging when required.

6. Note fluid intake both oral, and I.V.

7. Record urinary output. Insert urethral catheter if needed.

8. Note number and size of stools.

Laboratory Follow-up:

1. Examine blood slide for M.P. at 6 to 8 hourly intervals till parasite clearance.

2. Repeat required tests to watch P.C.V, anaemia, acidosis, jaundice, hepatic and renal failure and blood sugar for hypoglycaemia.

ERRORS IN MANAGEMENT OF SEVERE FALCIPARUM MALARIA

1. Misdiagnosis
2. Wrong assessment of severity
3. Faulty parasitology
4. Missed associated diseases/complications
5. **Missed hypoglycaemia**
6. Errors of fluid/electrolyte replacement
7. Deficient nursing
8. Errors of antimalarial therapy

a) Delay (b) Wrong and exaggerated fear of drug toxicity such as Quinine (c) Wrong dosage (d) Wrong route of drug therapy (e) Early cessation of treatment (f) Delay in treatment of pregnant women with malaria.

9. Mismanagement of respiratory complications.

10. Failure to control convulsions.

11. Lack of treatment for severe anaemia.

12. Inappropriate adjuvant therapies.

13. Delay in starting dialysis.

14. Delay in giving blood transfusion.

Treatment in Infants and Children

Drug Treatment

a. Uncomplicated acute attack with *P.vivax/ P.falciparum*:- Chloroquine is drug of choice. Total dose 25 mg per kg body weight administered over three days - 10 mg on first and second day, 5 mg on third day. **Do not use** parenteral route, as far as possible because it is not well tolerated by younger age group and adverse reactions are severe.

b. Severe attack of *P.falciparum* (Cerebral malaria):- Quinine I.V. 10 mg base per kg body wt, repeat 6 to 8 hourly diluted in Glucose solution given slowly as infusion. If needed, when patient becomes conscious and can take oral medicine, continue Quinine especially if suspected infection is due to Chloroquine resistant strain.

c. Suspected infection with resistant strain of *P.falciparum*:- Where temperature does not come down/parasites do not disappear in 72 hours-such cases are given Quinine I.V. or Sulfa (Sulfadoxine or Sulfalene) plus Pyrimethamine combination orally through Ryle's tube.

- Sulfa combinations act very slowly, therefore frequently evaluate clinical condition.

Management in Pregnancy

A good prognosis can be expected, if case is treated as medical emergency. It requires:-

- Early diagnosis
- **Administration of antimalarials in adequate dosages. In severe cases, Quinine should be given intravenously. The dosage regimen advocated does not precipitate abortion. Risk of abortion is higher in untreated cases.**
- All other supportive treatment should be given depending on clinical picture.
- During pregnancy the chemoprophylaxis in high risk malarious areas with small weekly single doses of Chloroquine or Chloroquine with Proguanil in areas with *P.falciparum* Chloroquine resistant foci may help in improving health of child and mother, but is not advocated in areas with low or moderate risk of malaria.

- Iron deficiency anaemia should be promptly controlled and high levels of haemoglobin should be maintained throughout the pregnancy. If condition of the patient warrants, blood or pack cell transfusion should be given.

"Do's"

Initial management of patients with severe malaria

1. Must use referral services early.

2. Keep patient in a semi-prone posture and proper nursing care.

3. Make a rapid clinical assessment and take blood for diagnostic purpose.

4. Calculate dose of drug.

5. Commence with antimalarial treatment early.

6. Check up blood sample to exclude hypoglycaemia, gluco strip method can be used for rapid assessment, follow-up with regular blood sugar estimation. If facility is not available, give I.V. glucose and check urine for sugar at regular intervals.

7. Assess state of hydration and measure urine output.

8. For younger age group, consider use of anticonvulsant drug. (Phenobarbitone 5-10 mg per kg body wt)

9. If temperature (rectal) is 39^0 C or above, tepid sponge, fan, antipyretic.

10. Lumbar puncture to exclude meningitis.

11. Patient should be constantly watched for prevention or early detection and treatment of complications.

"Don'ts"

The following are **not** to be used as supportive treatment:-

1. Corticosteroids - Dexamethasone (prolongs coma)

2. Mannitol urea

3. Heparin

4. Adrenaline

II. *P.vivax* INFECTION

The radical treatment in *P.vivax* is for anti-relapse action. Primaquine is the drug of choice. However, Chloroquine is given along with it so that clearance of asexual stages is also achieved. The dose schedule is as under:-

Chloroquine 10 mg/kg body weight + Primaquine 0.25 mg/kg body weight (Adult dose 600 mg Chloroquine and 15 mg Primaquine on day one and 15 mg Primaquine alone daily for next four days.)

Note:

i. Drug should be kept out of reach of young children. A single dose of 1.5 to 2 gm Chloroquine may be fatal to a toddler.

ii. If a *P.malariae* case is encountered, it should be treated as *P.vivax* case.

iii. Do not administer the drug on empty stomach.

iv. Discontinue Primaquine if toxic effects are observed.

In Indian programme for radical treatment of *P.vivax*, Primaquine is given for five days (15 mg per day in an adult). The 14 day radical treatment schedule advocated by some authorities for *P.vivax* is not considered necessary because difference between relapse rate with these two regimens is not very significant. In a control programme, five day schedule is acceptable and operationally feasible under Primary Health Care System. However, if a refractory case is seen the patient may be given Primaquine for 14 days under direct medical supervision, because of likely complication and emergency arising due to G6PD deficiency.

So far, in India no Chloroquine resistance has been reported in *P.vivax*.

CHEMOPROPHYLAXIS

It is discussed under Chapter-3, Section-3

SELECTED REFERENCES

1. Ray, A.P. Ed. (1991): Clinical aspects of malaria. Management of severe and complicated falciparum malaria published by the Indian Society for Malaria and other Communicable Diseases, Delhi - 110 054.

2. World Health Organisation (1966): Haemoglobinopathies and Allied Disorders. *Tech. Rep. Ser. No.* **338**.

3. World Health Organisation (1977): Cell mediated immunity and Resistance to infection. *Tech. Rep. Sec. No.* **519**.

4. World Health Organisation (1990): The clinical Management of Acute Malaria SEARO-WHO; New Delhi.

5

MALARIA PARADIGMS AND THEIR TRANSMISSION DYNAMICS

SECTION - I
CLASSIFICATION AND STRATIFICATION OF MALARIOUS AREAS

The focal distribution of malaria is determined by flight range of the vector species and availability of suitable breeding places, so that vector can maintain appropriate densities to establish man-mosquito contact for malaria transmission.

The endemicity of malaria in a locality is the ultimate cumulative expression of an interplay of all 'biotic' and 'abiotic' components responsible for malaria transmission in the area.

Locally the variations in malaria endemicity occur within a predetermined range over a period of time due to natural causes like seasonal as well as cyclical variations in rainfall and relative humidity patterns.

On the other hand, the effect on local endemicity of malaria by natural disasters like flood, drought and earthquake may be explosive but do not last over a long period of time. After these natural disasters, over a period of time, as the environmental conditions stabilise to pre-disaster conditions, the malaria endemicity also tends to revert to original level.

The permanent changes in local malaria endemicity are always due to man-made environmental changes in the area, like deforestation, urbanization, change in cropping pattern, introduction of irrigation, implementation of water resources development schemes, other projects, etc.

INTRODUCTION

Pre-historic man was a hunter and had no permanent abode. The hunting tribes followed the game-herds all over the landscape. In their wandering from place to place, they were subjected to a large number of diseases present in different biotopes, but they could not associate the disease prevalence to any particular environment. Later on, with the change over of life style to agriculture, the tribes felt the need of locating permanent settlements. These settlements were mostly established in areas with fertile soil, adequate rainfall and temperature gradients which could support the agricultural crops. The rainfall is usually intermittent, seasonal and unevenly spread over the year. Although intermittent rainfall could support the crops, it did not provide a regular water supply to the human settlements. A human settlement requires a regular supply of water to meet the daily needs of drinking water for family and domestic animals as well as other day-to-day activities. On account of these requirements, almost all permanent settlements were located near perennial sources of potable water such as rivers, lakes, etc. The communities of these permanent settlements were exposed to many health hazards and diseases prevalent in the ecosystem surrounding the settlement. Gradually the residents of the locality could associate the disease with the environmental conditions of the area. Out of many diseases which afflicted the community, fever was one of the major problems adversely affecting the health of the population and their economy. In the course of time, out of many types of fever prevalent in the area, the communities could recognise intermittent and remittent fevers. They found that intermittent fevers were seasonal and their incidence was high during the rainy season and coincided with agriculture sowing and harvesting. Romans and Greeks were the first to recognise the prevalence of intermittent fevers in association with swampy areas. They postulated that intermittent fevers were due to the 'bad odour' coming from the marshy areas and **thus gave the name 'malaria' - 'mal'=bad 'air' to intermittent fevers. This name has stuck to this disease, in spite of the fact that today the causative organism is known, the disease is still popularly called 'malaria'.**

Although for many centuries, how malaria or intermittent fevers were transmitted was not known, efforts were made to describe different biotopes where malaria was present.

CLASSIFICATION OF MALARIOUS AREAS

During early part of this century, the malarious areas of the world were classified on the basis of 'malaria prevalence' in the area. The degree of malaria prevalence was correlated with climatic conditions. Celli and later on Gill described Equatorial, Tropical, Sub-Tropical and Temperate Zones of malaria. (Fig- 5.1) Subsequently as wide variations in malaria prevalence were observed within each zone, Christopher, Pampana, and later on WHO (Kampala Conference, 1950) recommended the classification or stratification of malarious areas based on disease prevalence in the population surveyed for spleen enlargement in children in the age group of 2 to 9 years as hypo, meso, hyper and holo - endemic areas. Later on, it was suggested that another dimension might be introduced in this classification by adding infant and child parasite rates prevalent in community. However the grouping and the nomenclature of the endemicity of an area remained the same.

Only much later, attempts were made to classify or stratify malarious areas based on **'epidemiological profile'** of malaria in the area, as **'stable'** and **'unstable'** malarious areas. Attempts were also made to develop mathematical models of disease transmission and its epidemiology. The methodology was developed by Macdonald and Mostikovsky independently. These models explained malaria 'transmission dynamics' and disease epidemiology, but the control strategies based on these and adopted in areas like Garki project did not record much success. The atlas of Kenya and Tanganyika helped in understanding the malaria epidemiology in relation to land relief of the locality but did not lead to successful multi-disciplinary control strategy. The operational stratification has been done in El Salvadore, China, Vietnam, Turkey, Iran and recently in many countries of South East Asia. Except for China, the stratification based control programmes have not shown very good results; even in China the programme which had shown good progress till 1990 has recently recorded some setbacks. **Therefore, the adoptation of malaria stratification technique for planning a successful, 'cost-effective,' and 'sustainable' malaria control programme needs further research and refinement.**

Endemic types of malaria.
Gill, C.A. (1938) The Seasonal Periodicity of Malaria,
[London, Churchill.]

Fig- 5.1

Malaria transmission dynamics and its prevalence are governed by a large number of 'stable' and 'unstable', 'biotic' and 'abiotic' factors affecting vector, man and parasite. As a consequence of these, the 'malaria disease' entity presents a very complex phenomenon and in spite of research efforts spanning well over eight decades, it is still not completely understood.

Even prior to the new developments in the field of malaria epidemiology during the fifth decade, the malaria control/eradication programmes adopted the degree of 'malaria prevalence' i.e. endemicity levels as a criteria to implement the intervention strategies.

It is erroneous to think that under Malaria Eradication Programme, a blanket coverage with a single uniform approach was made in the entire country. Although the entire country was covered under the Malaria Eradication Programme, the measures adopted for interruption of transmission were different for various levels of endemicity. In some countries malaria control operations were applied in a phased manner, the high incidence areas were taken up first and low malarious areas were brought under operations later. The Indian programme used two rounds of insecticidal spray in meso/hyperendemic areas (pop 214 million approximately), while only one round of spray was given in hypoendemic areas (pop 156 million approximately). Thus, it is seen that nearly 39% of population of India in hypoendemic areas had operationally different intervention strategy.

The malaria eradication approach was based on **complete interruption of transmission** over a period of two to three successive years. This required **total coverage with residual insecticide.** The total coverage required that **a.** residual insecticide is applied to all indoor resting places of vectors in the operational areas, **b.** appropriate dose of residual insecticide is applied and remains effective during transmission period **c.** the insecticidal umbrella is applied before commencement of transmission period and remains effective during the entire transmission period.

To achieve this, many countries sprayed the residual insecticide for more than four decades. The number of rounds were determined by the duration of residual effect of insecticide used and length of the transmission period. In India two to three rounds of DDT were carried out to cover six months of monsoon transmission and an additional round was given in areas where spring transmission was observed.

Later on, during the course of the eradication programme, it became evident that some of the areas were not responding to the intervention measures as envisaged. The Directorate of NMEP classified/stratified the areas not only according to terrain but also took into account operational difficulties such as approachability, etc. which were adversely affecting the logistic support system and field operations. For operational purposes areas were classified into A,B,C & D (Fig- 5.2) with a view that total insecticidal coverage can be given in 'time' and 'space' during the transmission period. Wherever necessary the hilly and foothill areas were given three rounds of insecticidal spray instead of two rounds planned earlier. Foothills and undulating terrains were sprayed first before they could be cut off by rains. The operations were intensified with additional staff for spray and surveillance. This strengthening was sanctioned to cover difficult areas of the seven North Eastern States and Orissa. In these areas peripheral staff component was nearly doubled in strength. These areas did record improvement in malaria situation. However, all these measures could not prevent setbacks to the Indian programme. This was the period i.e. late sixties, when almost all control/ eradication programmes in the world suffered setbacks.

In 1977, eradication was substituted by Modified Plan of Operation (MPO). Under this approach, operational stratification was done and it was based on Annual Parasite Incidence (API) recorded in the area. The new approach resulted in more cost-effective utilization of resources and the incidence was reduced by approximately 69% within 5 years. But in spite of earlier success, further progress could not be made. In many quarters, it was mooted that the MPO was a failure. Technically it was an unqualified success unlike eradication, as it was able to maintain the gains achieved.

ZONING OF MALARIOUS AREAS OF INDIA: 1986

The In-depth Evaluation Committee-1985 recommended that a revised control strategy based on malariogenic stratification may be adopted in the country. The G.O.I. constituted a malariogenic

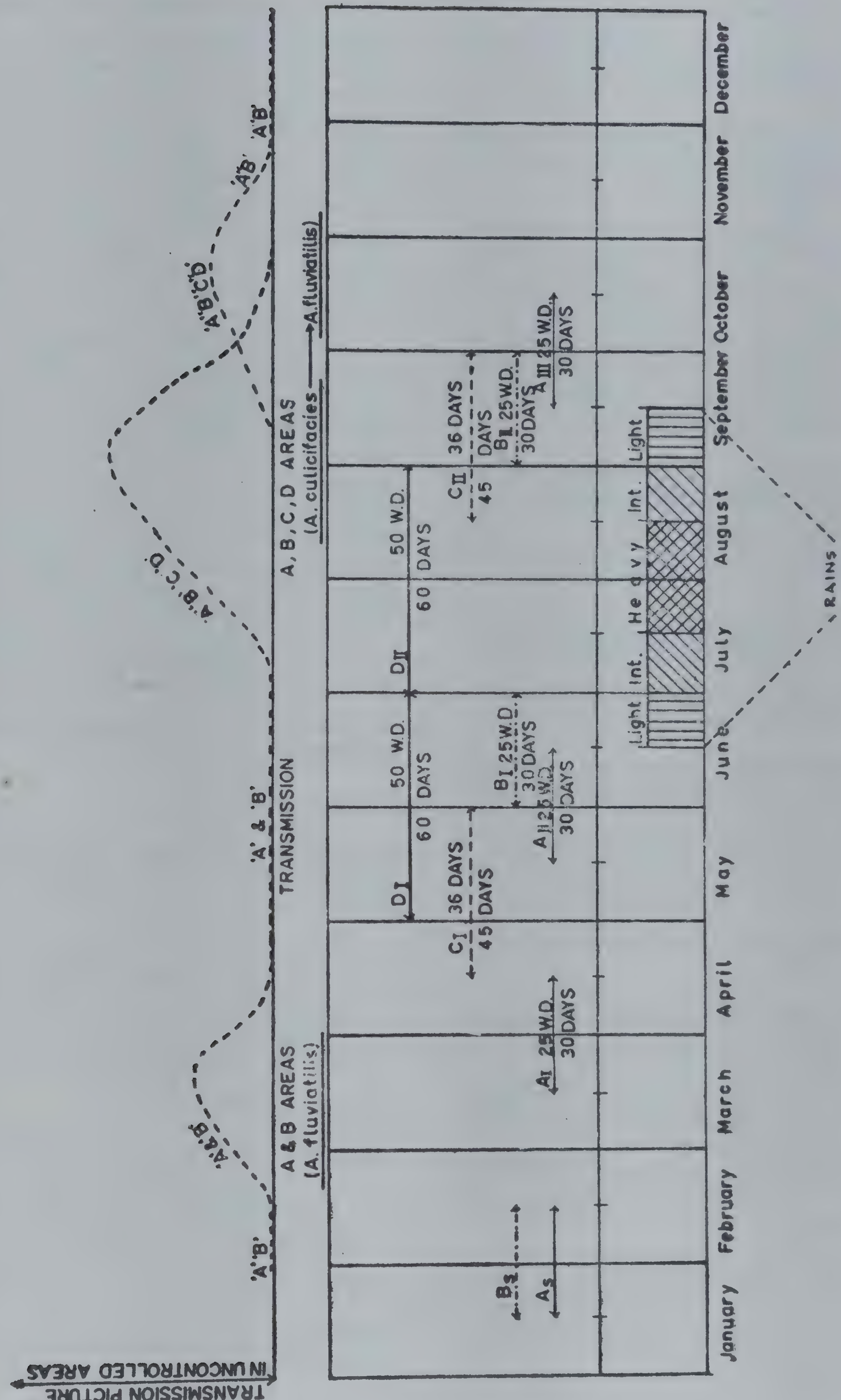

TRANSMISSION PICTURE IN UNCONTROLLED AREAS
A & B AREAS (A. fluviatilis)
'A' & 'B' TRANSMISSION
A, B, C, D AREAS (A. culicifacies) → A. fluviatilis
January
February
March
April
May
June
July
August
September
October
November
December
Light
Int.
Heavy
RAINS
36 DAYS
45 DAYS
50 W.D.
60 DAYS
25 W.D.
30 DAYS

Fig- 5.2

stratification committee in 1986 to:

a. Identify at the first instance the high risk, medium risk and low risk areas ;

b. Spell the measures needed for high risk areas on priority so that substantial reduction in malaria could be achieved ; and

c. Identify the types of measures needed for medium and low risk areas to achieve effective control and to prevent resurgence of the problem.

The Committee, as a preliminary exercise took 14 different variables into consideration for stratification and divided the country into the following seven strata (Fig- 5.3) .

I. **Non-Refractory Areas** with low to moderate epidemic potential of South India;

II. **Moderately Refractory Areas** with high epidemic potential of Central-Western India;

III. **Non-Refractory Areas** with moderate to high epidemic potential of North-Western India;

IV. **Non-Refractory Areas** with high epidemic potential in North-Western India.

V. **Non-Refractory Areas** with limited epidemic potential in Northern and Eastern India;

VI. **Refractory Areas** with high receptivity (malariogenic potential) in Central-Eastern and Eastern India; and

VII. **Refractory Areas** with high receptivity in North-Eastern India.

The stratification strategy suggested by this committee was based on 'Refractory' and 'Non-Refractory' nature of malaria. The term is arbitrary and misleading. Although it is true that in spite of more than two decades of insecticidal spray in so-called refractory areas, the malaria transmission could not be 'totally interrupted', but the malaria prevalence and mortality were reduced to a very great extent.

Further, this classification gives a broad general zoning of malaria in India; may be similar to various degrees of endemicity level and their observed response to intervention methods comprised of indoor insecticidal spray in almost all cases. It was also observed that each stratum had a population ranging from 30 to 164 million. Each stratum did not have a uniform epidemiological profile of the disease and wide variations existed within each stratum. So, further stratification at district level or even micro-level (village being the unit) is required to rationalise the control approach. Theoretically each village would require a specific combination of control measures to suit the local conditions depending on prevailing epidemiological profile of malaria transmission. No change in malaria control operation was made following the report of this Committee as the report was incomplete.

It must be emphasised that malariogenic stratification as suggested by different experts was not an academic exercise alone but it had an ultimate goal of defining programme objectives in different malariogenic strata. With the technology available it is not possible to achieve uniform reduction in malaria morbidity in all areas because of variable transmission potential of the area. It is, therefore, necessary that for each **'epidemiological niche'** appropriate control technology should be chosen so that it is possible to achieve malaria control and pragmatic goals should be laid down for each stratum in the country.

MALARIOGENIC STRATIFICATION BY 1986 COMMITTEE

Stratum No. I

Non-refractory areas with low to moderate epidemic potential i.e. large portion of South India.

It encompasses a major part of Peninsular India including the Deccan trap with Eastern and Western Ghats, the whole of Tamil Nadu, Kerala and Karnataka States, Southern portion of Maharashtra and Andhra Pradesh.

Mean Maximum Temperature	32.5 to 37.5° C
Rainfall	200 to 400 cms in Ghats 0 to 400 cms elsewhere
Total population	164.4 million
Tribal population	0 to 12.8%

Stratum No. II

Moderately refractory areas with high epidemic potential in Central-Western India.

Whole of Madhya Pradesh other than five districts in Eastern strip and the districts viz. Jhansi, Jalaun, Hamirpur, Banda and Allahabad

Parameters considered for stratification by Malaria Research Centre (MRC) and National Malaria Eradication Programme (NMEP)

		MRC			NMEP	
S. No.	Item	Height above MSL	Weightages		Height above MSL	Weigh-tages
1.	**Altitude**					
		* 300 m	5	* Coastal	- NA	0.5
		* 300-1000 m	3	* undulating and hills	-<1060 m	6
		* 1000-2000 m	1	* foothills	- NA	10
		* >2000 m	0	* Plain area with >50% area under irrigation	- NA	5
		(To be multiplied to total value)		* Plain area with <50% area under irrigation	- NA	3
				* hills - above	-1060 m	2
2.	**Ground Water** (cu.mt/hr.)	* < 50	1	not considered separately except 50% irrigated or non-irrigated areas under item 1		
		* 50-150	3			
		* >150	5			
3.	**Rainfall**	* <80 cm	4	average of last 5 yrs		
		* 80-120 cm	10	* 0-49 cm		1
		* 120-150 cm	5	* 50-99 cm		2
		* >150 cm	4	* 100-149 cm		4
				* 150-199 cm		6
				* 200-299 cm		8
				* 300 and above		10
4.	**Soil Type**	* mountainous	1	Not considered		
		* sub-mountainous & Alluvial	3			
		* Black	5			
5.	**Relief**	* <20 m	5	Not considered separately, only undulating terrain included under Item-I.		
		* 20-100	3			
		* >100 m	1			
6.	**Mosquito Breeding Index**	* <25%	1	Not considered		
		* 25-40%	3			
		* 40-60%	5			
		* >60%	7			
7.	**Vector Breeding Index**	* <5%	3	Not considered		
		* 5-10%	5			
		* >10%	10			

8.	**Vector Prevalence**	Only *An.culicifacies* sibling species were considered		* *An.balabacensis* $+ *An.minimus*	10
				* *An.culicifacies* + *An.fluviatilis*	8
				* *An.minimus*	8
				* *An.fluviatilis*	6
				* *An.sundaicus*	5
				* *An.philippinensis*	4
				* *An.culicifacies*	4
				* *An.stephensi*	2
9.	**Vectorial Capacity**	Values from items 1-8 above added vectorial capacity divided into		Not considered separately but probably taken into account under item 8	
		* Low	1		
		* medium	2		
		* High	3		
10.	**API**	Average of last 10 yrs. considered		average of last 5 years considered	
				* 20 and above	10
		* low	1	* 10-19	8
		* medium	2	* 5-9	6
		* high	3	* 2-4	4
				* 1	2
				* Less than 1	1
11.	**Epidemic Potential**	Not considered		Highest API value in last 5 years.	
				* >40	10
				* 20-39	8
				* 10-19	6
				* 5-9	4
				* 2-4	2
				* <2	1
12.	**Vulnerability**	not considered		migrating population as a percentage to the total population of PHC.	
				* >50	6
				* 25-49	4
				* 10-24	4
				* 0-9	0

Note:- $ *An. balabacensis* is to be read as *An.dirus*.

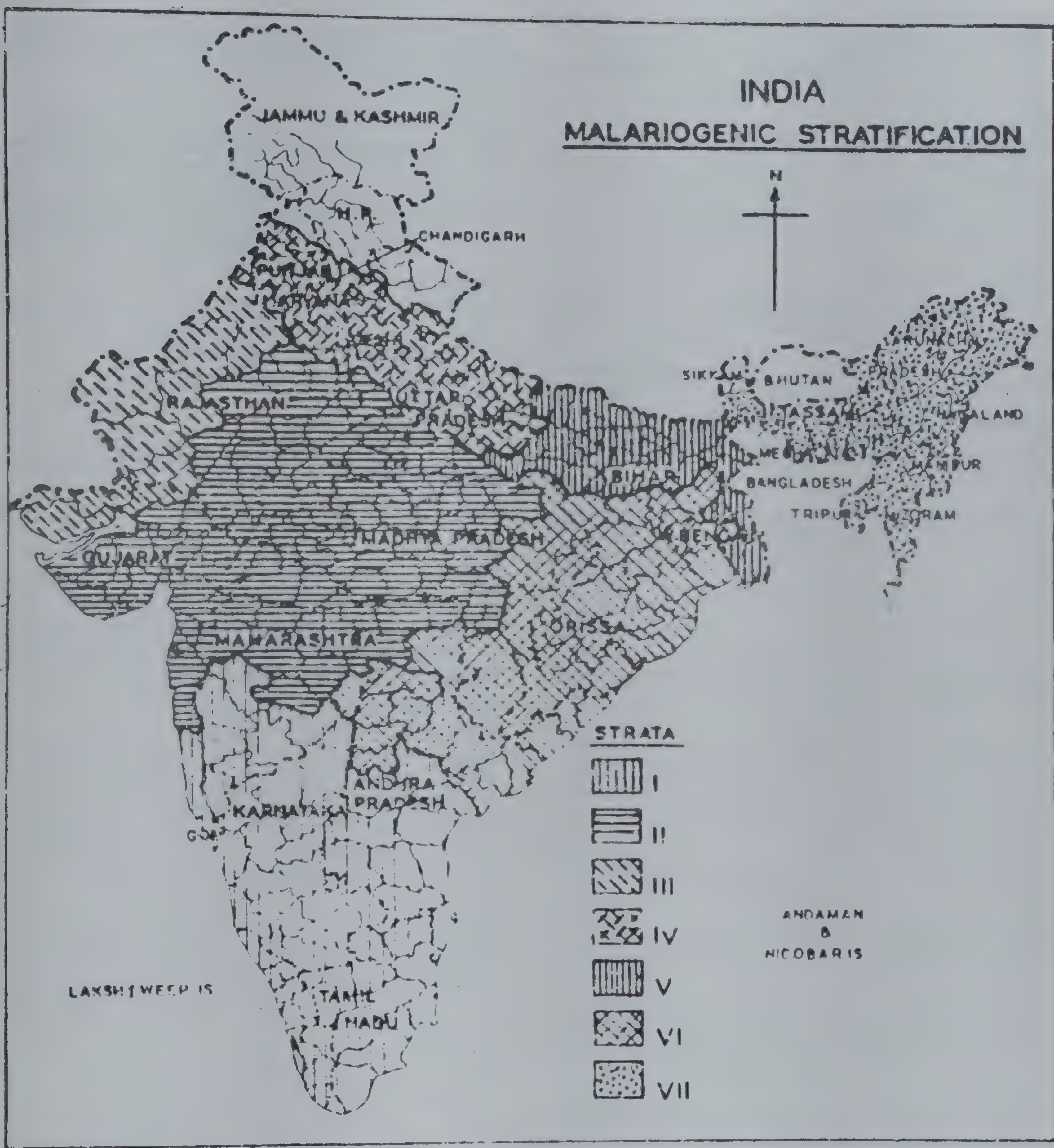


Fig. 1. Malariogenic stratification of India adopted by Malariogenic Stratification Committee 1986.

Fig- 5.3

of Uttar Pradesh, Gujarat except Rann of Kachchh and Banaskantha, Eastern and South-Eastern districts of Rajasthan and Northern parts of Maharashtra i.e. the Malwa plateau consisting of Aravalli ranges, Satpura and Mahadeo hills.

Mean Maximum Temperature	37.5 to 42^0 C
Rainfall	40 to 200 cms
Total population	147.7 million
Tribal population	4 to 31%

Stratum No. III

Non-refractory areas with moderate to high epidemic potential in North-Western India.

Western and Northern districts of Rajasthan viz. Ganganagar, Churu, Bikaner, Jodhpur, Barmer, Jalore and part of Sirohi and Rann and Banaskantha of Gujarat. This is an arid and semi-arid area.

Maximum Temperature more than 40° C reaching up to about 50° C in Jaisalmer

Rainfall	0 to 40 cms
Total population	11.9 million

Stratum No. IV

Non-refractory areas with high epidemic potential in North-Western India.

Jammu, Punjab, Haryana, Himachal Pradesh and adjoining areas of Uttar Pradesh except the Eastern strip, Western Himalayan Zone including the Sivaliks and the Ganga alluvium.

Mean Maximum Temperature	35 to 40^0 C
Rainfall	0 to 20 cms
Total population	98.8 million
Tribal population	Negligible

Stratum No. V

Non-refractory areas with limited epidemic potential in Northern and Eastern India.

Comprises the Eastern corner of Uttar Pradesh, Northern parts of Bihar and Eastern strip of West Bengal, Middle and Lower Ganga plains.

Mean Maximum Temperature	32.5 to 40^0 C
Rainfall	60 to 200 cms
Total population	87.5 million
Tribal population	3.2 to 12.8%

Stratum No. VI

Refractory areas with high receptivity (malariogenic potential) in Central-Eastern and Eastern India.

Orissa, Northern strip of Andhra Pradesh, Eastern strip of Madhya Pradesh, Chandrapur district of Maharashtra, Southern portions of Bihar, Mirzapur district of Uttar Pradesh in north, Chhotanagpur plateau, Chhatisgarh and offshoots of Northern part of Eastern Ghats.

Mean Maximum Temperature	35 to 40^0 C
Rainfall	60 to 200 cms
Total population	79.7 million
Tribal population	3.81 to 31.18%

Stratum No. VII

Refractory areas with high receptivity in North-Eastern India.

North-Eastern States of India viz. Assam, Meghalaya, Arunachal Pradesh, Manipur, Nagaland, Mizoram, Tripura and three districts of West Bengal (Jalpaiguri, Cooch-Bihar and Darjeeling). Eastern Himalayan ranges, Doars, Brahmaputra valley and the Garo, Khasi, Jaintia, Mikir, Pathai, Lushai and Naga Hills.

Mean Maximum Temperature	Less than 30^0 C
Rainfall	80 to 400 cms or above
Total population	32.2 million
Tribal population	12.8 to more than 31.18%

MALARIOGENIC STRATIFICATION ATTEMPTS BY NMEP AND MRC

In pursuance of the recommendations of the Stratification Committee, attempts to carry out malariogenic stratification were undertaken. Unfortunately the basic data on 14 parameters suggested by the Committee were not available for district areas in a continuous longitudinal time frame. It is almost impossible to generate the information required through general health services under PHC system. The Malaria Research Centre has attempted a modified stratification approach and has taken nearly a decade to generate or gather existing data for stratification in respect of one State only i.e. Uttar Pradesh and has touched only those areas where malaria is transmitted by *An.culicifacies* alone.

The Directorate of NMEP has a smaller list of parameters and has done stratification of Karnataka, Rajasthan, Maharashtra and Andhra Pradesh only partially, with the information available within the system, but they are finding it difficult to validate it for other areas as some of the weightages assigned to parameters require further modification and field testing.

1. All values assigned to different parameters by MRC and NMEP are arbitrary and not based on any field observation or experiment.

2. The MRC calculated the vectorial capacity using Garret Jone's formula:

$$C = \frac{ma^2 \quad p^n}{-\log_e \ p}$$

p = Probability of survival which indirectly is a function of longevity.

n = Incubation period of parasite in mosquito.

m = vector density per man

a = biting habit

ma = man biting rate

The temperature and humidity are most important determinants of 'vectorial capacity', they influence the 'longevity of mosquito', and 'incubation period' of parasite in vector. The seasonal temperature (summer & winter) and seasonal rainfall with humidity (summer & winter) are depicted in Fig- 5.4 and Fig- 5.5 respectively. On the other hand 'vector density per man' (m) is the most difficult to quantify and cannot be determined precisely, as it is influenced by exophagic/endophagic habit of the vector; and human behaviour is influenced by factors like occupation and nocturnal habit of local population, their indoor or outdoor sleeping habits.

3. Mosquito breeding index and vector breeding index under items 6 and 7 respectively are a product of irrigated area, while it does not take into account water logging and stagnation.

i. Mosquito breeding index $= \dfrac{\text{Total irrigated area}}{\text{Total geographical area}} \times 100$

ii. Vector breeding index $= \dfrac{\text{Canal irrigated area}}{\text{Total irrigated area}} \times 100$

It is true that while canal irrigation tends to produce water logging and water stagnation but rationale of dividing canal irrigated area by total irrigated area is not very clear.

4. Substitution of 'm' in vectorial capacity formula by breeding index instead of mosquito density and man animal ratio is also subject to question. However, this may be the only method in the absence of the availability of hard data in respect of mosquito densities.

5. Biting habit 'a' estimated as a function of Human Blood Index (HBI) and gonotropic cycle is the best which can be done under the present situation. However, the length of gonotropic cycle may differ from vector to vector and season to season. Environmental factors like temperature influence the gonotropic cycle. Thus results of a single study over a short period of time will be influenced by seasonal conditions and at best can be considered as a rough estimate as even under the best of the circumstances their accuracy is doubtful and of a limited value only.

6. As far as NMEP technique is concerned, they have combined many variables under one item. This presents difficulties in assigning weightages for different epidemiological situations and thus has a large limitation for countrywide approach.

Having considered and compared the methodology adopted by MRC and NMEP, it is to be seen which one of these can be adopted to Indian conditions for formulating the revised strategy of malaria control. **So far a switch over to new control operations based on stratification has resulted in worsening of malaria situation.**

MALARIOGENIC STRATIFICATION -- SOME EPIDEMIOLOGICAL CONSIDERATIONS

Malariogenic stratification and identification of sub-paradigms of malaria in a country based on all epidemiological features of the disease sound very scientific, their use in planning a malaria control strategy suited to local conditions seems to be the best method for economically utilizing the meagre national resources for disease control. But this is impossible to achieve meaningful stratification and even more difficult to plan and implement control operation as each village or a part thereof is a unique epidemiological entity. The manpower required at periphery to collect objective information is neither available nor

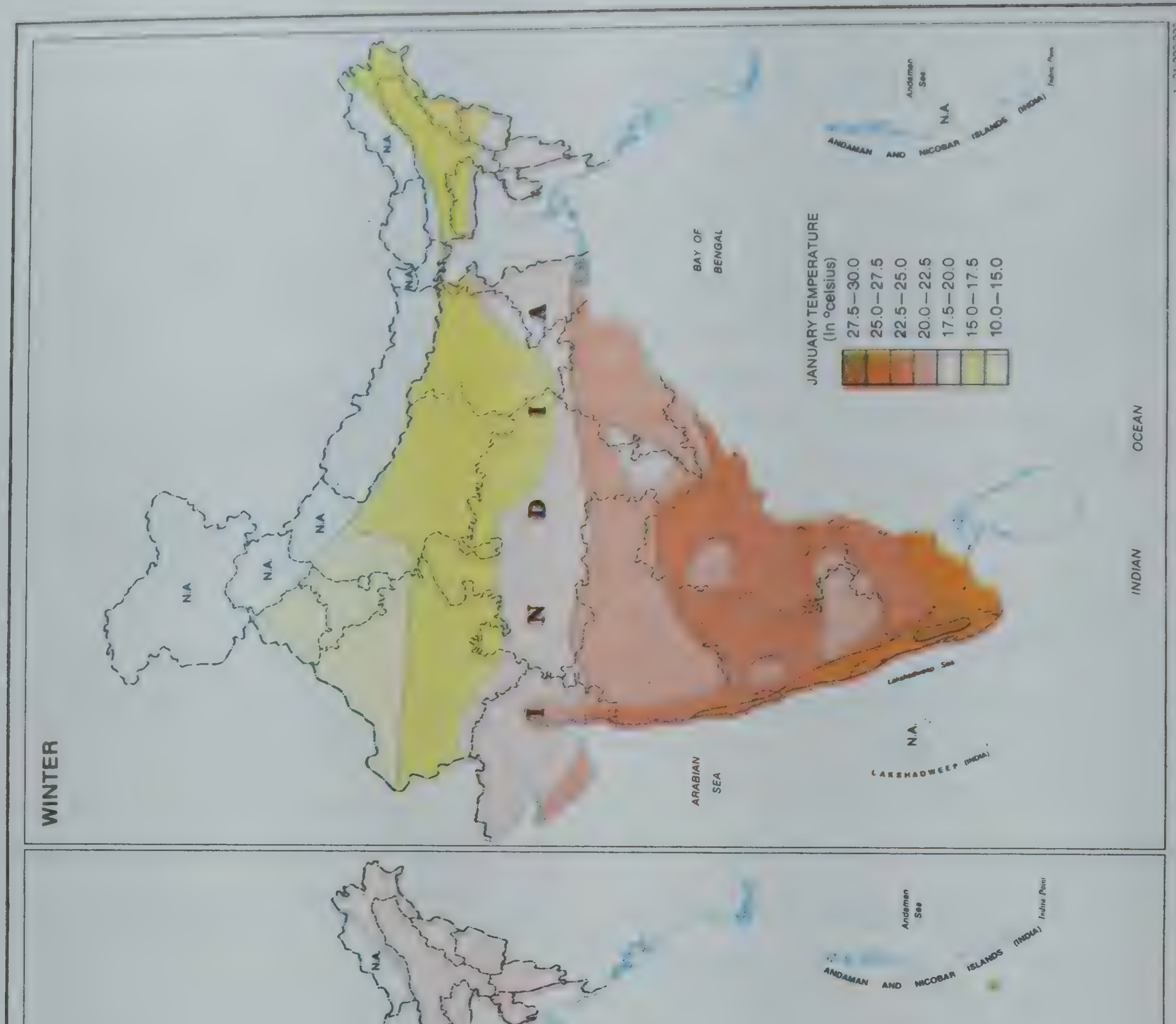

WINTER
JANUARY TEMPERATURE
(In °celsius)
27.5—30.0
25.0—27.5
22.5—25.0
20.0—22.5
17.5—20.0
15.0—17.5
10.0—15.0
SUMMER
JULY TEMPERATURE
(In °celsius)
32.5—35.0
30.0—32.5
27.5—30.0
25.0—27.5
20.0—25.0
INDIA
BAY OF BENGAL
ARABIAN SEA
INDIAN OCEAN
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)
N.A

Fig- 5.4

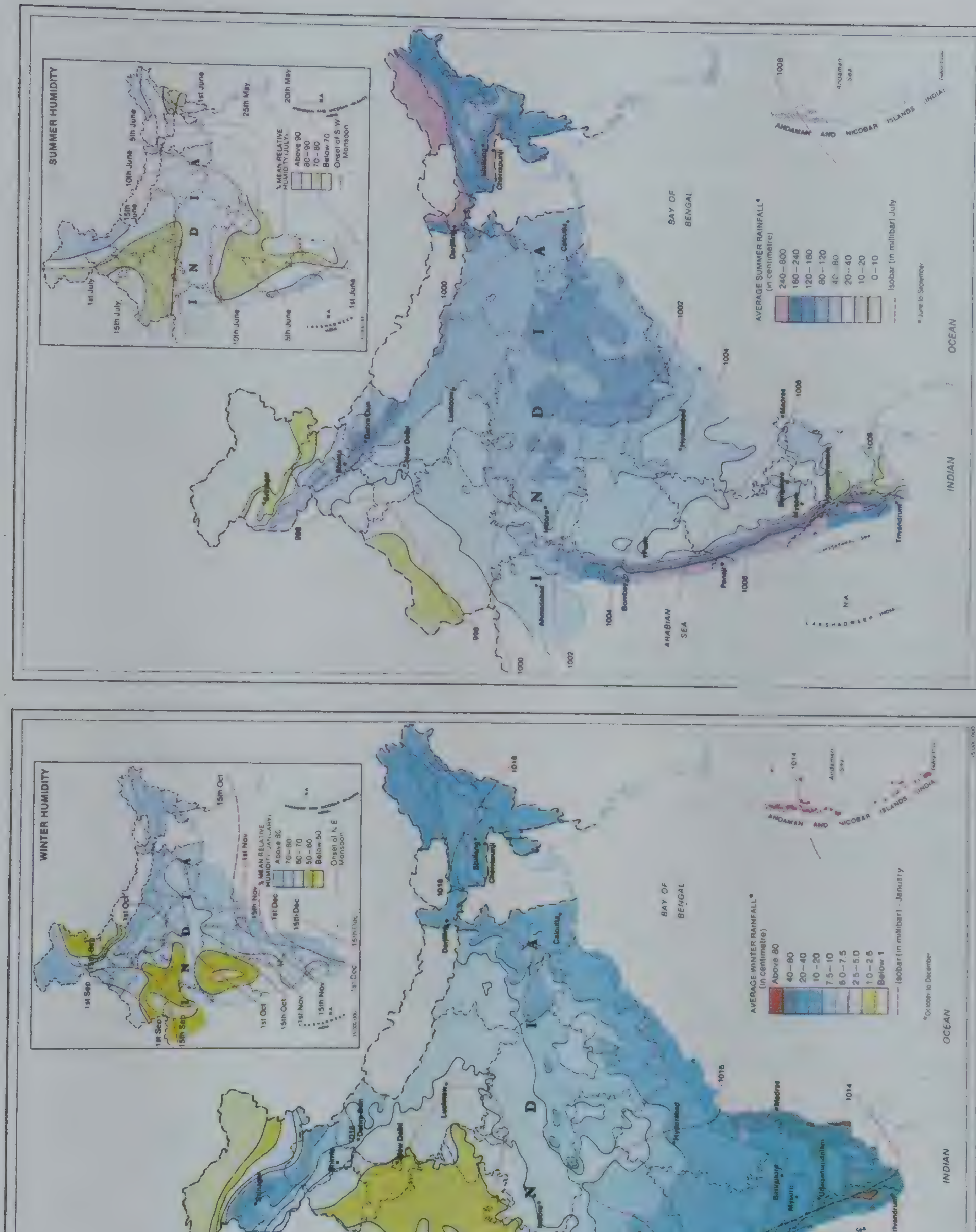

SUMMER HUMIDITY
% MEAN RELATIVE HUMIDITY (JULY)
Above 90
80-90
70-80
Below 70
Onset of S.W. Monsoon
AVERAGE SUMMER RAINFALL*
(in centimetre)
240-800
160-240
120-160
80-120
40-80
20-40
10-20
0-10
Isobar (in millibar) July
* June to September
BAY OF BENGAL
ARABIAN SEA
INDIAN OCEAN
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)
WINTER HUMIDITY
% MEAN RELATIVE HUMIDITY (JANUARY)
Above 80
70-80
60-70
50-60
Below 50
Onset of N.E. Monsoon
AVERAGE WINTER RAINFALL*
(in centimetre)
Above 80
40-80
20-40
10-20
7.5-10
5.0-7.5
2.5-5.0
1.0-2.5
Below 1
Isobar (in millibar) - January
* October to December

Fig- 5.5

technically competent. There is no expertise at District or State level to analyse the situation in a meaningful manner and utilise the same for planning and implementing the most appropriate control strategy with the meagre resources available at local levels, through the Primary Health Care organisation.

Thus it is necessary to formulate a rational approach for identifying a malaria paradigm having specific features in respect of local transmission dynamics to lay down most appropriate control methodology.

Similarly, broad classification as to the types of malaria i.e. hypo, meso, hyper and holo endemic or Savanna, desert, highland fringes, river valley or agriculture associated, forest related, war or socio-political disturbance related malaria although conveys a classification associated with specific geophysical or social problem related malaria but in itself gives no indicators or pointers for selecting specific control measures.

CLASSIFICATION OF MALARIA EPIDEMIOLOGICAL TYPES RELATED TO HUMAN ACTIVITY IN INDIA

(Adopted from WHO Document)

1. Agriculture Related Malaria

i. Irrigated Agriculture Malaria
- Rice field malaria
- Irrigation canal malaria
- Tube-well malaria
- Reservoir/pond related malaria
- Sugarcane cultivation malaria

ii. Non-irrigated Agriculture Malaria
- Cotton plantation malaria
- Tapioca plantation malaria
- Tea garden/Coffee plantation malaria

iii. Tree Plantation Malaria
- Rubber tree plantation malaria
- Coconut tree plantation malaria
- Fruit orchard malaria

iv. Animal Grazing Malaria

2. Forest Economy Related Malaria

i. Deep Forest Malaria
- Gem/Gold/Ore mining malaria
- Hunting/Food gathering malaria

ii. Forest Fringe Malaria
- Settled cultivation malaria
- Shifting cultivation malaria
- Resettlement malaria
- Animal grazing malaria
- Logging/firewood collection malaria

3. Urban Malaria
- Urban malaria
- Peri-urban malaria
- Slum malaria
- Industrial malaria

4. Industry Related Malaria
- Coal/Ore Mining malaria
- Developmental Project malaria

The above classifications only broadly identify a situation where human population can be exposed to risk of malaria. But to organise a control programme for each situation, detailed investigations on transmission dynamics are required. Without authentic information on various factors related to local transmission dynamics most appropriate technology cannot be chosen for malaria control.

IDENTIFICATION OF MALARIA PARADIGMS - 1994

During 1994, there was a sudden upsurge of malaria in India. Epidemics were recorded in the States of Rajasthan, Manipur and Nagaland. The State of Rajasthan recorded about four fold increase in number of deaths due to malaria. To look into the causes of these epidemics and deteriorating malaria situation, Government of India appointed a Committee of Experts to identify the worst affected malarious areas and to suggest specific remedial measures. The Expert Committee reviewed the malaria problem from

the records of the Directorate of National Malaria Eradication Programme (NMEP) and other agencies. The NMEP had identified four paradigms of malaria namely **i. Epidemic prone areas. ii. Tribal Areas, iii. Project areas and iv. Urban areas.**

After reviewing the current status of malaria in India as well as the technology options available for malaria control, the Committee stated:

'The Committee observes that though appropriate technology for control of malaria is available for different epidemiological paradigms of malaria, the administrative indifference, the organisational weakness, the low prioritisation to malaria under the health services and apathy of middle level and the peripheral workers in the States have led to periodic epidemics and high mortality'.

The Committee while laying down criteria for identification of 'high risk' areas stated:

'An area should fulfill one or more of the following epidemiological parameters to qualify for implementation of special control measures'.

Rural Areas

1. Recorded deaths due to malaria (on clinical diagnosis or microscopic confirmation of *P.falciparum*) locally acquired infection in an endemic area, during any of the last three years.

2. The Slide Positivity Rate (SPR) index is to be used for the identification of the areas as follows:-

a. Doubling of SPR during the last three years provided the SPR in second or third year reaches 4% or more.

b. Where SPR does not show the doubling trend as above but the average SPR of the last three years is 5% or more.

3. *P.falciparum* proportion is 30% or more provided the SPR is 3% or more during any of the last three years.

4. An area having a focus of Chloroquine resistant *P.falciparum* (A Chloroquine resistant PHC will be characterised by detection of more than 25% of R II and R III level cases in a minimum sample of 30 cases), as per WHO recommendations.

5. Tropical aggregation of labour in project areas.

6. New settlements in endemic/receptive and vulnerable areas.

Urban Areas

1. All 15 cities/towns identified as high risk areas.

2. Among the remaining cities/towns presently covered under UMS, the SPR 10% and more during the last three years.

3. Any other urban area with a population of 50,000 or more and SPR more than 5% or the ratio of clinical malaria cases to fever cases more than one third as per hospital/dispensary statistics during the last calendar year.

The Committee further stated -

'Taking the view, that malaria is an exclusively local phenomenon, the disease prevalence and epidemiological factors vary from area to area, the Committee endorses that approach to malaria control in any area should have the following two main activities'.

Disease management :

Through early diagnosis and prompt treatment (EDPT).

Selective Suitable Intervention Measures:

These measures should be directed towards transmission interruption/control. They can be antiadult measures like insecticidal spray, or antilarval measures with chemical larvicides, biocides and water management to prevent mosquito breeding. Both these measures can be supplemented by personal protection measures to prevent man-mosquito contact.

Emphasis was laid on disease management through early diagnosis and prompt treatment (EDPT). The measures suggested for EDPT were more or less uniform for all malarious paradigms identified but the selective suitable intervention measures recommended by the Committee for each malaria paradigm were different to suite the local conditions.

In epidemic prone areas, major vector is *An.culicifacies* but in some of the epidemic prone pockets it is supplemented by *An.stephensi.* This composite geographic area was identified in Punjab, Haryana, Western Uttar Pradesh, Rajasthan,

Madhaya Pradesh and a few pockets in other States. But this area has pockets with variable transmission dynamics.

The second paradigm was 'Tribal Areas' which include areas of seven North-eastern States, tribal areas of Andhra Pradesh, Bihar, Gujarat, Madhaya Pradesh, Maharashtra, Orissa and Rajasthan. **All tribals do not live in the same environmental conditions. Their exposure to malaria also varies due to cultural and socio-economic life-styles, therefore tribal malaria is not a single entity.**

The third paradigm suggested was project areas, and a separate paradigm for urban areas was identified. Both these paradigms also exhibit wide variations in their transmission potential from locality to locality.

The Committee went ahead to sub-classify these paradigms of malaria into:-

1. Plain irrigated areas (tube-well irrigation)

2. Plain areas with sandy soil without water logging

3. Plain desert areas.

4. Plain coastal areas

5. Undulating hills and foothills areas and malaria in organised sector, etc.

It is observed that apart from broad classification given in (Table- 5.1), the Committee has further divided the epidemic prone areas into different sub-paradigms of malaria, on the basis of the endemic potential of the area, correlating the endemicity levels with the presence of malaria vector. They took into consideration the effect of the vectorial capacity of local vector and other factors related to the transmission dynamics in the area. The classification of areas is still broad. Within each sub-paradigm of malaria there could exist a pocket with a highly divergent endemicity profile of malaria.

Generally speaking the short-term intervention measures listed by the Committee in the tables may be able to produce effective control of malaria over a period of one to two years, but the long-term sustainable malaria control strategy will immediately require a further analysis of transmission dynamics of smaller sub-sections in each of the sub-paradigms. Only then a new malaria control strategy with a mix of most appropriate technology suited to local conditions can be implemented so that further setbacks can be avoided, because the short term measures recommended may become ineffective , in the long run, in controlling malaria incidence in the country. It is, therefore, necessary to study the transmission dynamics of different paradigms of malaria in India.

Table- 5.1: SHORT TERM MALARIA CONTROL MEASURES RECOMMENDED FOR HIGH RISK AREAS IN DIFFERENT PARADIGMS OF MALARIA

S. No	Malaria Area	Qualifying epidemio-logical parameter	Disease Management	Intervention Measures (if not specified, to be implemented for two consecutive years)
1.	**Epidemic Prone Areas #:** Punjab, Haryana, Western U.P., Rajasthan, M.P., and a few pockets in other States (vector *An.culicifacies*)	1 and 2 of rural areas. (Page No. 143)	- Case detection and presumptive treatment of fever through DDC/ FTD/ACD/PCD - Blood slide collection & examination - Radical treatment with priority to *Pf* cases within 48 hours **- Action Required** - Infrastructure according to present norm to be placed in position. - Each village to have FTD @ 1000 pop. or part thereof if the distance between the villages/hamlets is more than 3 kms. - DDC can be established if FTD is not practicable due to non-availibility of suitable local resident to man it. - PHC MO should decide opening of DDC/FTD according to local situation. - Provide malaria clinics in selected Subcentres away from PHC - Alternative drug in Chloroquine resistant *Pf* areas - IEC as per Annex-7 & 8 of O.M. MAP.	**Short term intervention measures** - Residual insecticidal spray, 2 rounds with suitable insecticide in selected villages recording high malaria incidence - Implement anti-epidemic measures in case of focal outbreak - IEC as per Annex-7 & 8 of O.M. MAP.

The epidemic prone paradigm also includes areas under the vectorial influence of *An.stephensi* and *An.annularis* besides sibling species of *An.culicifacies*. These areas require specific transmission control measures which are detailed in the Sub-Tables (also vide Item No.: 10 of O.M. MAP.)

S. No	Malaria Area	Qualifying epidemio-logical parameter	Disease Management	Intervention Measures (if not specified, to be implemented for two consecutive years)
2.	**Tribal Areas $:** All the 7 North-Eastern States & Tribal areas of A.P., Bihar, Gujarat, M.P., Maharashtra, Orissa & Rajasthan	1 and 2 of rural areas. (Page No.143)	- Intensified IEC as given in Annex -7 & 8 of O.M. MAP. - Disease Management as given under S.No.1 - MPW should be able to identify severe cases of malaria requiring referral to PHC - PHC should be well equipped to tackle all severe cases of malaria - Alternative drug in Chloroquine resistant *Pf* areas - **Action Required** Link worker : One for 2.000 population. He should also work as FTD and carry all blood slides of his area to PHC or malaria clinic twice a week. He should also bring replenishment of drugs and microslides for FTDs in his area. Other actions as given in S.No.1.	**Short term intervention measures** 2 rounds of suitable insecticidal spray in all qualified villages of PHC. - Selective third round in a few villages with epidemic potential (The spray coverage of rooms should not be less than 80% within the spray schedule) **Long term intervention measures** - Use of impregnated bednets - Chemoprophylaxis to pregnant women - IEC as per Annex-7 & 8 of O.M. MAP.

* The Tribal paradigm includes areas under the vectorial influence of *An.minimus*, *An.fluviatilis*, *An. culicifacies* and *An. dirus*. These areas require specific transmission control measures which are detailed in the Sub-Tables.

S. No.	Malaria Area	Qualifying epidemio-logical parameter	Disease Management	Intervention Measures (if not specified, to be implemented for two consecutive years)
3.	**Project Areas:**	1,2,5 & 6 of rural areas. (Page No. 143)	Mass screening of labour/ incoming population should be continuously done if transmigration is frequent - All incoming persons from high risk tribal areas should be given presumptive treatment along with a single dose of 45 mg Primaquine (adult dose) - Alternative drug in Chloroquine resistant *Pf* areas - **Action Required** - Additional establishment of infrastructure for malaria surveillance and referral hospital/dispensaries and malaria clinics in all projects - All other measures as given under S. No.1.	**Short term intervention measures** - Antilarval measures with chemical larvicides at weekly intervals/bio-environmental control measures including biocides **- Action Required** - Establish an antilarval organisation - Residual insecticidal spray 2 rounds in all human dwellings including the new hutments whenever they are built during the transmission period with a suitable insecticide IEC as per Annex-7 & 8 of O.M. MAP.

S. No.	Malaria Area	Qualifying epidemio-logical parameter	Disease Management	Intervention Measures (if not specified, to be implemented for two consecutive years)
4.	**Urban Areas:**	1,2 & 3 under urban areas & any urban area with 1 & 2 of rural areas. (Page No. 143)	- Active surveillance in slum areas at weekly intervals - Activated passive surveillance in hospitals and dispensaries, by providing extra worker to man a malaria post - Presumptive treatment - Radical treatment with priority to *Pf* **- Action Required** - Provide adequate staff for active surveillance in slum areas @ one worker for 20,000 pop. - Establish one malaria clinic for 50,000 population or part thereof: - The location of malaria clinic should be preferably adjoining slum area if possible and wherever feasible its location should be existing dispensary	**Short term intervention measures** - Antilarval measures with chemical larvicides at weekly intervals/ bioenvironmental control measures including biocides - Indoor space spray with pyrethrum in and around 50 houses of every malaria positive case. **- Action Required** - Establish an antilarval organisation - Residual insecticidal spray 2 rounds in all human dwellings including the transmission period with a suitable insecticide in peri-urban area - IEC as per Annex-7 & 8 of O.M. MAP.

Sub-Tables - with Reference to 5.1

S. No.	Malaria Paradigm	Qualifying cut off criteria	Disease Management	Intervention Measures (if not specified to be implemented for two consecutive years)
1. A.	**Plain Irrigated Areas** (Tube well) usually SPR below 2%. Eastern Uttar Pradesh like (Deoria & adjoining districts) North Bihar. (Vector *An.culicifacies* where sibling species B is predominant)	1 and 2 of rural areas. (Page No. 143)	-Case detection through FTD, ACD, PCD -Blood slides collection only from cases having fever. Presumptive treatment -Radical Treatment to positive cases. -Priority of R.T. in *Pf.*cases within 48 hours. **Action Required** -Strengthen the PHC infrastructure and referral services as per norms of PHC system -Provide malaria clinics at Subcentre levels. -IEC as per Annex-7 & 8 of O.M. MAP.	**-Short term intervention measures** - One round of residual insecticidal spray with DDT 1gm/sq metre in selected villages showing disease prevalence of SPR 2% or above and also *P.falciparum* infection. The round of insecticidal spray should be scheduled to cut off peak transmission period. -IEC as per Annex-7 & 8 of O.M. MAP.
1.B.	**Plain Areas** with sandy soil without waterlogging, SPR 2% or above. Madhya Pradesh, Rajasthan and in the parts of districts of adjoining States. (Vector *An.culicifacies* sibling species A & C)	1 and 2 of rural areas (Page No. 143)	-same as above **Action Required** - create a post of malaria link worker open malaria F.T.D. as given S.No.1 in areas wherever population is sparse. - per sq.km	**-Short term intervention measures** Two rounds of DDT 1 gm/sq metre in selected villages only,showing SPR of 2% or above and *P.falciparum* infection. - In villages with SPR 2% or above but with *P.v.* infection only, one round of DDT spray to cut off peak transmission period. -IEC as per Annex-7 & 8 of O.M. MAP.

S. No.	Malaria Paradigm	Quali-fying cut off criteria	Disease Management	Intervention Measures (if not specified to be implemented for two consecutive years)
1.C.	**Plain Desert Areas** with SPR 2% or above Rajasthan: *An.culicifacies* in pockets, main vector *An.stephensi*	1 & 2 of rural areas. (Page No. 143)	-Case detection through FTD, ACD, PCD. -Blood slides to be examined. -Presumptive treatment to all fever cases -Radical treatment to all cases and *Pf* cases to be given priority for RT within 48 hours. **Action Required** As given in S.No.1 above -Strengthen the PHC infrastructure according to national norms. -Provide malaria clinics at selected subcentres which are far away from PHC. -FTD - one FTD for 1000 population or part there-of, if the distance between villages is more than 3 Kms. -**Link Worker**: one for 2000 population. He should also work as FTD and carry all blood slides of his area to PHC or malaria clinic twice a week. He should also bring reple-nishment of drugs and micr-oslides for FTDs in his area. **Note:** Keep watch on parasite reservoir build up.	**-Short terms intervention measures** -Antilarval measures with temephos in prescribed dosage in water storage tanks every week **NOTE**- Keep watch on vector density build up. -In case of threat of an epidemic/ early epidemic period, all actions as recommended under epidemic control as given under item 11 of O.M. MAP. to be implemented. -Take anti-epidemic measures in selected villages falling under cut off parameter. -Followed by a single round of DDT spray at 1 gm/sq.metre or 2 gm/sq.metre Malathion.

S. No.	Malaria Paradigm	Qualifying cut off criteria	Disease Management	Intervention Measures (if not specified to be implemented for two consecutive years)
1.D.	**Plain Coastal Areas** with SPR above 2% and moderate epidemic potential: Coastal areas of Orissa, Andhra Pradesh & Tamil Nadu (Vector *An.culicifacies* and *An.annularis*)	1 & 2 of rural areas. (Page No. 143)	Same as above under S. No. 1	**Short term intervention measures** -Focal spray irrespective of transmission period in and around *Pf.* household -Or focal spray in and around *P.v,* households during transmission period. -One round of spray in selected villages with SPR above 2% with DDT 1 gm/sq. metre with 80% or above coverage of rooms. -Implement anti-epidemic measures in case of a focal outbreak.
	Plain Coastal Areas with SPR below 2% where epidemics are unknown: Kerala & other Eastern Ghat plains & foothills. (Vector *An.culicifacies*) Note: Threat due to importation of cases from Gulf countries.	1 & 2 of rural areas. (Page No. 143)	- Blood smears collected from cases with fever only or migrants from other countries & states with fever history or fever cases. -Presumptive treatment to fever cases should be selective based on local condition. -Full Radical treatment to cases. -Full Radical treatment to *Pf* positives within 48 hours with appropriate antimalarial (Some cases from Gulf countries may have resistant *Pf* infection)	**Short term intervention measures** Focal and other remedial measures in and around household of *Pf* cases.

S. No.	Malaria Paradigm	Qualifying cut off criteria	Disease Management	Intervention Measures (if not specified to be implemented for two consecutive years)
2.A.	**Undulating Hill/ Foothill Areas** with riverine belts and perennial water sources, SPR above 2%: Areas like foothills in Himalayan region, Assam, W.Bengal, Eastern Ghat & Indian peninsular Hills /foothills. Vectors-a) *An.culicifacies An.minimus / An.fluviatilis* b). *An.culicifacies / An.minimus, An.dirus.*	1 & 2 of rural areas. (Page No. 143)	Same as under S.No.1	**Short term remedial measures** 2 rounds of DDT 1 gm/sq.metre in all villages of PHC. qualifying under criterion. -A selective third round in a few villages with epidemic potential with DDT 1 gm/sq metre. Note: Coverage of rooms should not be less than 80% and spray schedule tailored to curtail the local transmission period.
2.B.	**Malaria in Organised Sector/ARMY/BSF/ Border Road Organisation and Tea Gardens** (Vector:*An.culicifacies, An.minimus An.dirus*	1 & 2 of rural areas. (Page No. 143)	**-Short term intervention measures** -Compulsory screening of Labour -Blood Smear collection through ACD,PCD & FTD. Blood smear examination Presumptive & Radical treatment of all positive cases with priority to *Pf* infection within 48 hours. **Action Required** -Establishment of FTD -Establishment cf infrastructure for ACD -Strengthening of referral hospital/ Dispensary. -Establishment of malaria clinic -Establishment of malaria link worker.	-Selective spray with DDT or Organo-phosphorus compounds in villages with SPR 2% or above 2 or 3 rounds of spray depending upon the length of transmission period. -Use of personal protection measures such as impregnated bed-nets, etc.

O.M.-MAP.: Operational Manual for Malaria Action Programme - 1995

SECTION - 2
FACTORS INFLUENCING TRANSMISSION DYNAMICS

A large number of factors related to 'human', 'parasite' and 'vector bionomics' have a role in determining transmission dynamics of the area. These factors are briefly outlined hereunder. They are discussed in detail for each malaria paradigm in Section-3.

Human Factors

The human physiology and activities associated with socio-economic development modify the human exposure to malaria and the response of the body to parasite invasion. For example, the genetic traits related to haemoglobinopathies, Red Blood Cell characteristics and immunological response of individuals to malaria parasite have been investigated very extensively. The malaria parasite is one of the intra-cellular parasites and this infection is a good model for the study of cellular and parasitic interaction. The sequential stages of selection, invasion, intra-erythrocytic development, to final liberation of merozoites show variations on account of both the human and parasite genetic properties.

1. Nature of Innate Resistance to Malaria Infection

a. Innate Immunity

Some persons residing in a highly malarious area never acquire infection while other members of the same family suffer from the disease. Whether this is due to complete innate immunity of the individual to malaria parasite or some other factor has not been conclusively proved.

b. Duffy Antigen

To invade a Red Blood Cell (RBC), a merozoite must be able to attach itself to the receptors on the surface membrane of the RBC. The finding by Miller that individuals with erythrocytes lacking in Duffy blood antigen (Fy^a Fy^b) are refractory to malaria infection initiated further studies. It was observed that *P.vivax* was unable to invade the Duffy negative blood cells. As Duffy blood group is virtually absent in West African population, *P.vivax* infections are more or less absent in the indigenous population. This points to the fact that Duffy coating on RBC wall may modify receptors in respect of *P.vivax* merozoites.

c. Blood Groups

Further investigation on the incidence and severity of malaria, its distribution in different blood groups have failed to produce any concrete evidence on specific predilection of malaria parasite to any specific blood group.

2. Haemoglobinopathies

The geographic distribution of Haemoglobin HbS sickle cell trait in holo-endemic falciparum malaria is very striking and suggests that maintenance of high frequency of Haemoglobin HbS in population might be due to selective advantage of heterozygotes against the adverse effect of *P.falciparum*.

The above two examples suggest that frequency of a mutants population in a locality may be at advantage over normal human genepool when exposed to malaria, and thus in some parts of the world these gene pools are maintained by strong selection pressure exerted by the parasite prevalence in the locality. The phenomenon is well described in many text books on malaria and therefore the topic is not discussed here in detail. Briefly HbAS protects against *P.falciparum* infection, inference being that *P.falciparum* merozoites may not be able to invade RBCs having HbAS or they do not grow or divide in these cells or the parasitised cells with HbAS are rapidly removed from circulation by the patient's defence mechanism before parasite reaches the stage of mature schizont. The phenomenon is still not very clear.

Haemoglobin C is another genetic variant found in Africa. It has partial effect on the growth of *P.falciparum*. It has been demonstrated that growth of *P.falciparum* in culture is adversely affected in erythrocytes with HbCC.

Foetal Haemoglobin

Foetal Haemoglobin (HbF) is present in human foetus during pregnancy. The production of normal Haemoglobin starts during the mid pregnancy. But

even at birth 80% of the haemoglobin in the infant is still HbF type. It has been suggested that cells with HbF are not suitable for growth of *P.falciparum*. The mechanism is still not clear.

Beta-thalassaemia - The homozygote children for beta-thalassaemia die early but it has been observed that beta-thalassaemia confers some resistance to infection with malaria parasite in heterozygotes of beta-thalassaemia.

Glucose-6-Phosphate-Dehydrogenase (G6PD)

Studies have shown that malaria parasites in G6PD deficient cells are more easily damaged by effect of oxidants. It is suggested that *P.falciparum* does not grow well in G6PD deficient cells, although the correlation is not very strong.

Generally speaking it may be stated that the genetic characteristics of the erythrocytes and presence of haemoglobinopathies usually confer some sort of protection against infection with malaria parasite. The protection may be due to i. alteration in surface receptors of the blood cells, ii. factors impeding intracellular development of parasite, iii. the parasitised cell may be more rapidly removed from circulation by lymphoid macrophage system of the individual before schizogony is completed.

In the western part of India, a considerable heterogeneity in G6PD deficiency has been observed and the frequency of the deficient gene varied from 17.3 per cent in Parsi community in Cutehi Bhanushalis to 10.0 per cent in Mahars. In northern India, a considerable variation was observed among various groups of population. In the eastern part of the country, Assamese and Bengalis show about 5.0 per cent, where as among the tribals it is much higher - in Khasis, 7.0 per cent, Santhals 14.0 per cent and in Angami Nagas 27.1 per cent. In the southern part, the deficiency has been noted to vary up to 9.0 per cent.

In general, G6PD deficiency gene is more frequent in tribals than in non-tribals, though it is absent in the Toda and Kadar tribes in Southern India. Among the tribals of Bastar district, which is highly endemic for malaria it has been reported at 25.0 to 28.0 per cent. Also in recent studies, a high incidence of G6PD deficiency was found among tribals as compared to non-tribals living in malarious areas of Hyderabad region.

Haemoglobin S (sickle cell haemoglobin), which provides protection from *P.falciparum* infection, is the quite widespread haemglobin variant in India and it is considered to be predominant among the tribals. However, besides tribal populations some other groups possess this gene, though in a low frequency.

Sickle cell trait in the various tribal groups in South India ranges from 4.0 to 40.0 per cent. Some scheduled castes in Andhra Pradesh showed high incidence - up to 28.0 per cent. In Western and Central India, this gene was found ranging from 4.0 to 22.0 per cent among tribals. Oriyas of Orissa and Bhils of Rajasthan are reported to have this gene in appreciable frequencies.

A number of studies have been carried out on the selection advantage of sickle cell gene for malaria infection in India. The first report on this aspect was published in 1974 among Mahars of Aurangabad, where a good correlation between the endemicity of malaria and the incidence of HbS trait was observed. However, subsequent studies to estimate the correlation co-efficient between the frequency of HbS and endemicity of the malaria infection in different districts of Madhya Pradesh failed to show a significant statistical correlation. As such, it is possible that if HbS offers any advantage in Indian population, it must be only limited, though the severity of the infection may be reduced by its presence.

Though a direct evidence of the genetic trait of beta-thalassaemia to malaria was not demonstrated convincingly, in a study in 1964 there was a suggestive geographic correlation between the frequency of the gene and a regional history of malaria. A lower frequency of the trait among malarious groups as compared to non-malarious groups was reported from tribes in Dadra & Nagar Haveli in 1982.

3. Nutritional Status

It is outside the scope of this book to discuss the details of various aspects related to the effect of nutritional status of an individual on malaria infection. Extensive work has been done to correlate nutritional deficiency in an individual and its effect on malaria infection. The results are uncertain and somewhat controversial.

4. Asymptomatic Malaria Case

Asymptomatic malaria case is usually described as

'a person found positive for malaria parasite in the absence of clinical symptoms. In some cases, spleen enlargement may be observed'. These cases are usually termed as asymptomatic malaria carriers. The term is defined in malaria terminology as under :-

'Condition in which malaria parasites are present in the blood; if this condition in the human subject is not accompanied by pyrexia or other symptoms of malaria except for a possible enlargement of the spleen, it is known as asymptomatic parasitaemia, and the person exhibiting the condition is known as a symptomless parasite carrier. Asymptomatic parasitaemia may be primary (occurring before primary-attack symptoms) or secondary.'

Apart from the above, there is no further well-defined classification of cases found positive for malaria infection without clinical symptoms.

Role of asymptomatic carriers in malaria transmission has been debated for a long period of time. In case of ***P.vivax***, it has been demonstrated that repeated attacks or exposure to infection, the transmission blocking immunity develops. This immunity renders the gametocytes incapable of completing their life cycle in mosquito. A similar process is also postulated in case of *P.falciparum* but is yet to be proved conclusively. In case of *P.vivax* all the stages of malaria parasite including gametocytes appear in the peripheral blood simultaneously. The infectivity of gametocyte to a mosquito is estimated to last for 72 to 120 hours, while in case of *P.falciparum*, gametocytes are late to appear and are presumed to be infective for a longer period of time. Considering that there is a development of transmission blocking immunity in human beings, the role of such gametocyte carriers in transmission of malaria requires a further detailed investigation. It has also been observed that development of immunity has adverse effect on production of gametocytes resulting in low density of gametocytes in the peripheral blood of an immune person. What proportion of mosquitoes feeding on patients with low gametocytaemia will become infected and how many of these gametocytes will be able to complete the gonotrophic cycle resulting in sporozoite positivity is a debatable point. At the present juncture it is difficult to quantify the role of asymptomatic parasite carriers in transmission of malaria in hyper endemic areas. However, a few vectors are bound to become infective by such carriers of *P.falciparum* and if they inoculate even a small number of sporozoites in a non-immune person such as infants and young children, intense transmission in a receptive area will ensue.

5. Cases with Prodromal Symptoms Showing Parasitaemia

i. Theoretically it is possible that a person having fresh infection with malaria parasite may be found positive without clinical symptoms. This can occur in cases who have high fever threshold to a given level of parasitaemia, due to natural or acquired immunity.

In such cases the patient usually presents with prodromal symptoms of headache, lassitude, bodyache, etc. The fever threshold to a given parasitaemia is high and patent parasitaemia is observed in microscopic examination before clinical sign and symptoms of malaria appear. This category of patients may show parasitic infection with any of the two parasites, *P.vivax* and *P.falciparum*.

ii. In the second category there are cases of *P.falciparum* infection who had a fever episode which was not investigated for presence of malaria parasite or was forgotten by the patient and later on during fever free period the slide of the person was examined and found positive for *P.falciparum* gametocytes. In these instances previous fever history is not properly elicited by the examining physician. Such cases are seen in endemic areas of malaria where adults are repeatedly exposed to malaria and have developed high levels of immunity which could limit the parasite density in the peripheral blood to a low level resulting in mild sign/symptoms of malaria which do not incapacitate the person and are easily forgotten but parasitaemia is microscopically detectable.

6. Housing

Human dwellings widely vary in their construction from area to area. In rural areas, the human dwelling is constructed with the material locally available, more so in tribal areas. A well constructed house of bricks and mortar with well laid out ventilation does not provide adequate safe resting place for mosquitoes. The mosquitoes prefer to rest in dark corners. They avoid light

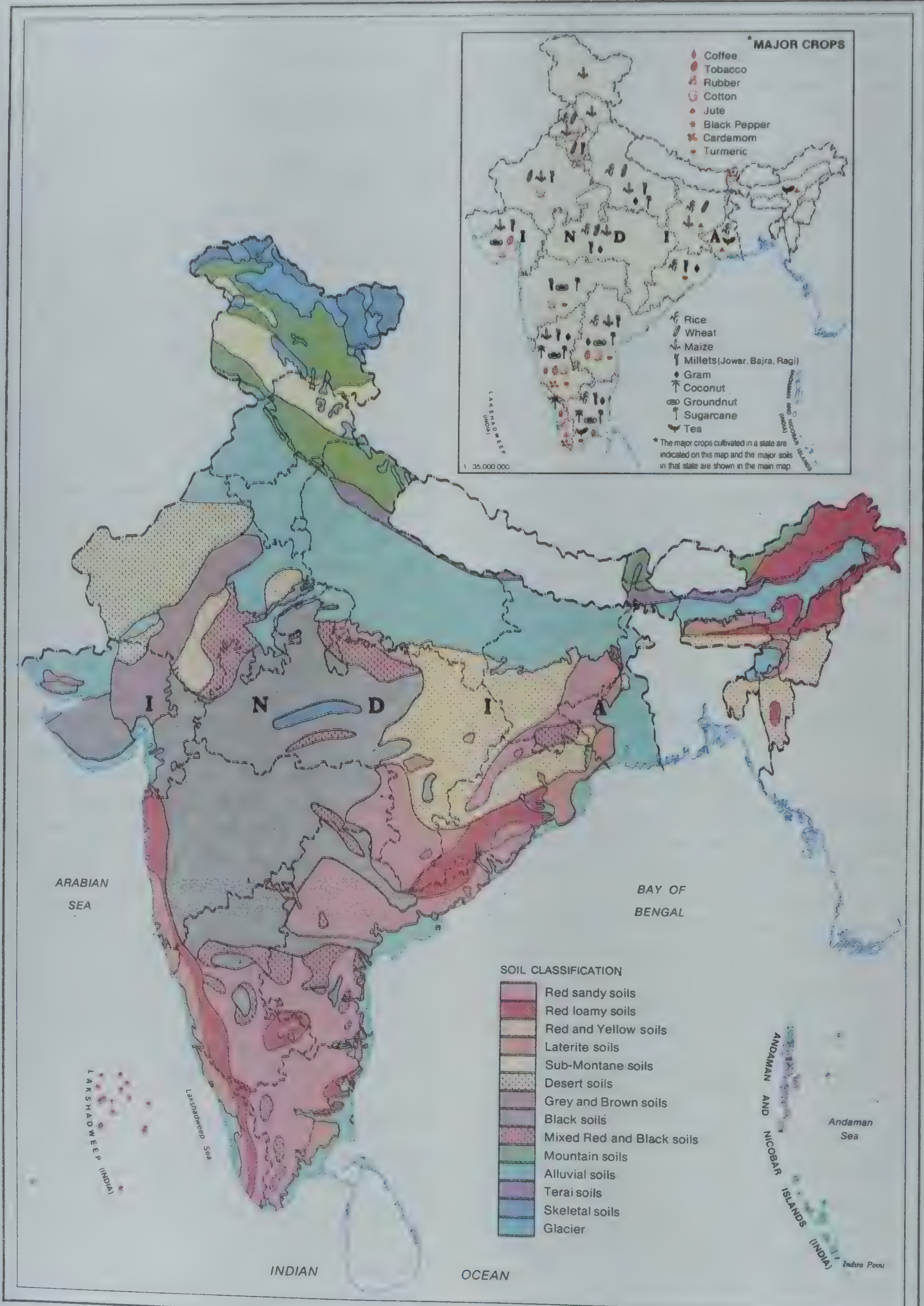

*MAJOR CROPS
Coffee
Tobacco
Rubber
Cotton
Jute
Black Pepper
Cardamom
Turmeric
INDIA
Rice
Wheat
Maize
Millets (Jowar, Bajra, Ragi)
Gram
Coconut
Groundnut
Sugarcane
Tea
* The major crops cultivated in a state are indicated on this map and the major soils in that state are shown in the main map.
1 : 35,000,000
INDIA
ARABIAN SEA
BAY OF BENGAL
SOIL CLASSIFICATION
Red sandy soils
Red loamy soils
Red and Yellow soils
Laterite soils
Sub-Montane soils
Desert soils
Grey and Brown soils
Black soils
Mixed Red and Black soils
Mountain soils
Alluvial soils
Terai soils
Skeletal soils
Glacier
LAKSHADWEEP (INDIA)
Lakshadweep Sea
ANDAMAN AND NICOBAR ISLANDS (INDIA)
Andaman Sea
INDIAN OCEAN
1 : 15,000,000

Fig- 5.6

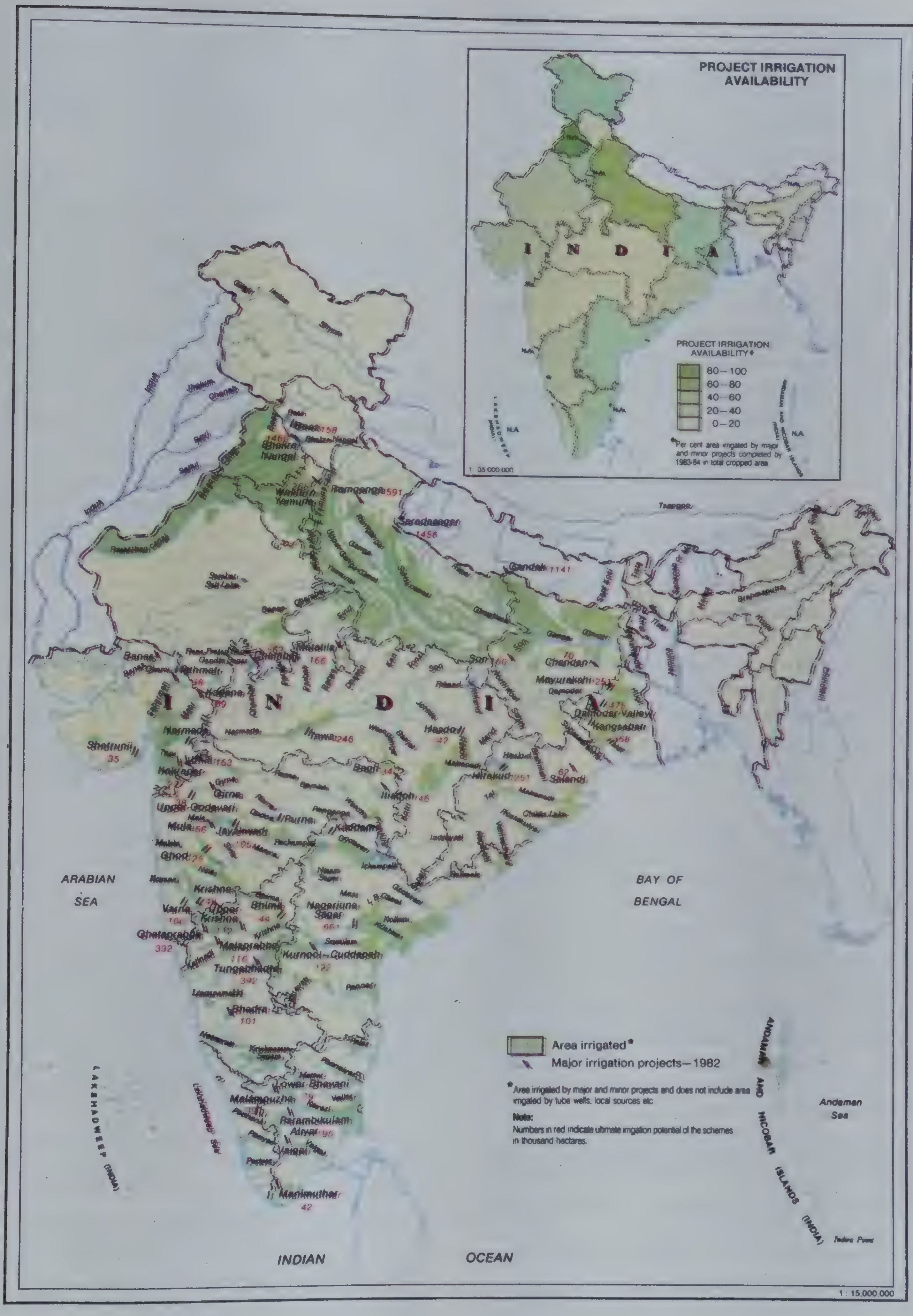

PROJECT IRRIGATION AVAILABILITY
PROJECT IRRIGATION AVAILABILITY*
80 – 100
60 – 80
40 – 60
20 – 40
0 – 20
*Per cent area irrigated by major and minor projects completed by 1983-84 in total cropped area
1 : 35 000 000
ARABIAN SEA
BAY OF BENGAL
INDIAN
OCEAN
Andaman Sea
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)
Area irrigated*
Major irrigation projects – 1982
*Area irrigated by major and minor projects and does not include area irrigated by tube wells, local sources etc.
Note:
Numbers in red indicate ultimate irrigation potential of the schemes in thousand hectares.
1 : 15,000,000

Fig- 5.7

and direct air current. On the other hand, the houses having mud walls and thatched roof with poor ventilation provide suitable resting places to mosquitoes. The mosquito can rest in the crevices of the mud walls as well as in the thatch of the roof where more suitable microclimate is available for its survival. In some parts of the country, the houses are constructed with walls of bamboo matting and thatched roof. These houses provide easy ingress to mosquitoes into the human dwellings through slits in the bamboo matting of the wall. In these houses, the favourite resting place is usually in a dark corner and thatched roof. If the mosquitoes are endophagic and endophilic, residual insecticide spray in a well constructed human dwelling is the most suitable control technology.

Apart from these permanent dwellings, in areas of Jhum cultivation, forest and project camps, usually small sheds are constructed with partial walls or even without walls. These shelters are more exposed to air current, rain, etc. However, the thatched ceiling of these temporary constructions provide sufficient and safe resting places for the mosquitoes. Under these conditions, in spite of spray operations with residual insecticides, malaria transmission continues especially in areas where the vector is exophilic.

7. Clothing

In most of the tribal areas and among poor sections of the society, the clothing and covering of the body is scanty because of hot and humid climate. Thus a large proportion of the body is exposed to mosquito bites. Therefore, the clothing also plays a significant role in malaria transmission in tribal areas and poor communities. However, the quantum of transmission due to poor clothing has never been ascertained with a fair degree of accuracy under field conditions.

8. Sleeping Habits

In India, in the eastern part of the country and some areas of Southern India, the local population is accustomed to sleep under mosquito nets provided they can afford it. To some extent they are protected against malaria infection by sleeping under a mosquito net. In the colonisation schemes (Dandakaranya area), each family was provided one mosquito net as a protection against mosquitoes especially malaria vectors. Usually male member of the family slept under the mosquito net. The children and other members of the family slept without protection of mosquito net. In these areas, it was observed that malaria incidence was more in females and young children.

The outdoor sleeping habit in some areas during hot and humid period is prevalent in many parts of the country especially when the nights are clear and without rain. In these areas malaria is transmitted by vector species which are exophilic and exophagic. Logically it sounds reasonable that endophagic mosquito while trying to enter a house finds the host outdoor near the dwelling and takes blood meal on this person and later may rest inside or outdoor to digest blood meal depending upon atmospheric conditions. A similar situation is usually encountered in migrant labour in project areas and forest camps and it is one of the reasons for high incidence of malaria in this migratory population.

9. Occupation Related Malaria

a. Agriculture and Irrigation

Areas where irrigation channels are not properly maintained and high vector densities are observed, in such villages, the transmission is much higher than surrounding villages where canal irrigation is not practised.

Soil classification with major crops and major irrigation projects in India are depicted in Fig- 5.6 and Fig- 5.7 respectively.

The temporary hutments in agriculture fields are constructed almost in all areas of the country where a farmer stays overnight for protection of crops from wild/stray animals. The practice is more rampant in Jhum cultivation areas. In these temporary hutments without proper walls, spray operations do not control malaria transmission.

Agriculture related malaria has another dimension on account of large scale movement of population from one part of the country to another for sowing, transplanting and harvesting of crops. These activities are usually undertaken during the rainy season or just after the rains. Therefore, the migratory population living in temporary huts constructed for the purpose is more exposed to malaria transmission.

b. Cattle Grazing

India has probably the largest cattle population in the world. The cattle grazing is one of the major activities in many parts of the country. It has been observed that cattle grazers from different malaria paradigms migrate from place to place in search of cattle fodder. Cattle grazers from Gujarat-Kachchh, Maharashtra and Rajasthan migrate to the forested areas of Madhya Pradesh, Orissa and Andhra Pradesh where they live in temporary hutments and their camps are transient. They change their camps very frequently depending on the grazing facilities available in the area. Thus they move when the fodder becomes scarce and search out new pastures. Because of the temporary nature of camps, frequent shifting of sites, the cattle grazers are exposed to natural transmission of the area. It is very difficult to implement any control measure in this migratory population. They are not covered under surveillance by the Primary Health Care Organisation on account of temporary nature of their camps and frequent shifting.

c. Migration of Population - General Remarks

Factors Influencing Population Migration

In the medieval ages, population migrations were prompted by sudden appearance of pestilences heralding heavy morbidity and mortality or depletion of food resources for the people or their livestock. In recent times, the migration of population has become a socio-economic phenomenon. It occurs due to marginalisation of rural holdings where economy of rural population is shattered due to increase in family size as a consequence of the population explosion. The rural population migrates to other areas in search of livelihood and to maintain or prevent deterioration in living standard of the family. The phenomenon of population migration from Europe to other parts of the world is very well documented and large number of reasons have been put forth for the same. The industrial development in a country also triggers migration of rural population to industrial and urban areas.

As the migration of population in India is one of the major socio-economic phenomena, it is a result of marginalisation of rural holdings whereby the economy of the rural population is adversely affected due to increase in family size. The rural population in order to maintain its living standards migrates to other areas in search of employment. In rural areas, there is temporary unemployment during lean agriculture period and further adds to seasonal population migration which leads to exposure of migratory population to intense malaria transmission in the new environment. Some of the major occupations in search of which labour moves from place to place are **i**. agriculture, **ii**. developmental projects, **iii**. mining, **iv**. exploration of forest resources, **v**. cattle grazing, **vi**. fishing and **vii**. nomadism. Other migratory movements occur on account of natural calamities i.e. drought and flood. This migratory phenomenon is widespread in the country and has adverse effect on malaria control activities.

Net migrants along with migration pattern and interstate labour movement are given in Fig- 5.8 and Fig- 5.9 respectively.

A study by UNICEF team carried out in Orissa to ascertain the migratory trends among unskilled labour showed that tribals, scheduled castes and other backward socio-economic groups migrate more frequently. It was also observed that nearly 2/3rds of these people moved along with their families. Only small proportion goes to urban areas as labour force. A well-known phenomenon of tropical aggregation of labour and associated malaria have been studied and described by a large number of malariologists. The labour migrating from malarious to non-malarious areas bring immune and non-immune population together coupled with local and imported parasite reservoir at the site of temporary camps. As a result of this, focal outbreaks of malaria are sometimes explosive involving the migratory population and then gradually extending to local population, if not checked in time. Experience shows that it is difficult to control malaria among the itinerant labour force. Such explosive outbreaks have been observed in almost all labour camps of transient nature in forests, developmental projects, urban construction areas, road building operations, etc.

d. Road Transport and Construction

Another aspect of occupation related malaria is movement of large number of road transport vehicles from one part to another part of the country. These transporters carry goods like coal, ore, etc. from malarious areas to industrial

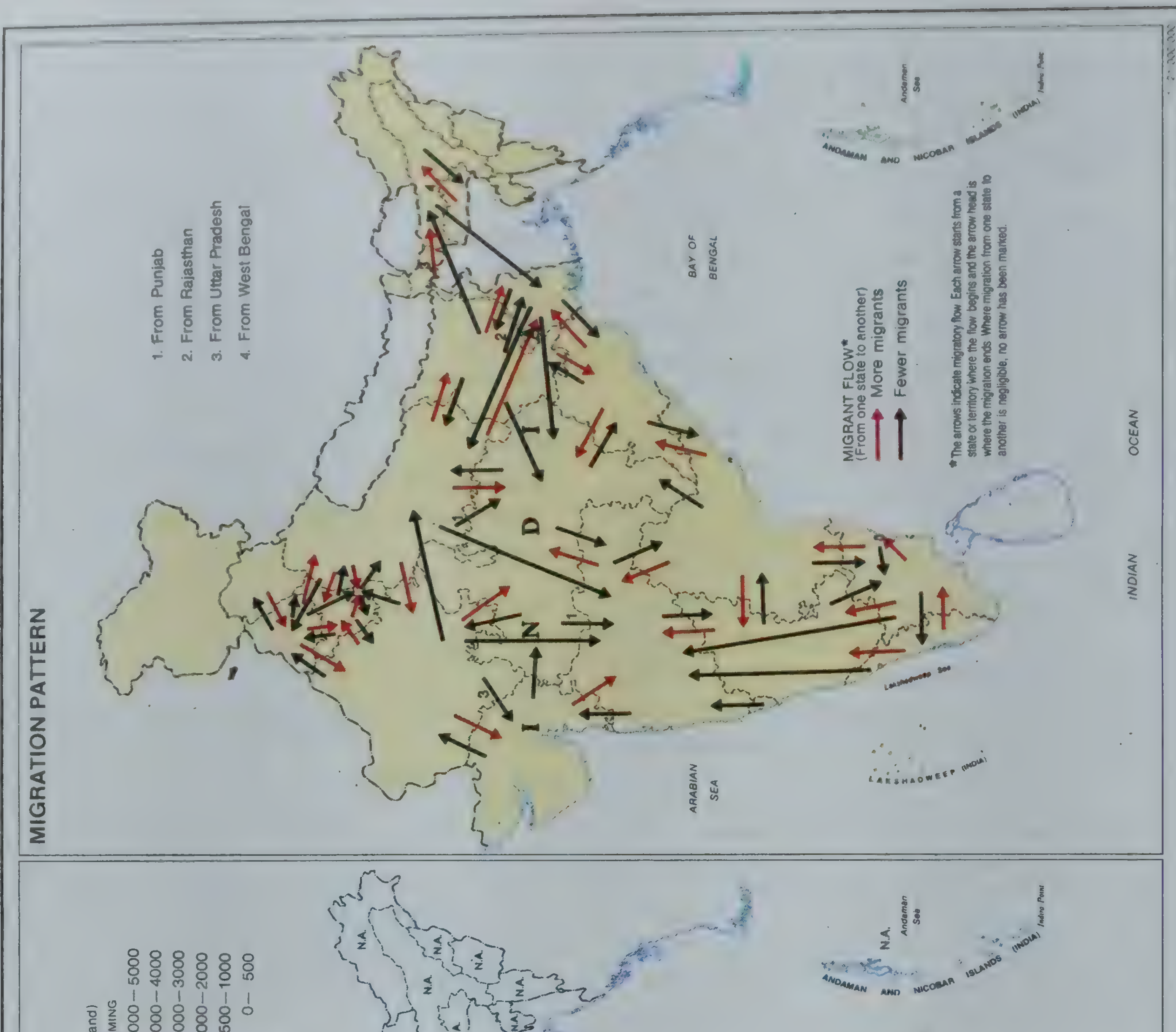

MIGRATION PATTERN
1. From Punjab
2. From Rajasthan
3. From Uttar Pradesh
4. From West Bengal
MIGRANT FLOW*
(From one state to another)
More migrants
Fewer migrants
* The arrows indicate migratory flow. Each arrow starts from a state or territory where the flow begins and the arrow head is where the migration ends. Where migration from one state to another is negligible, no arrow has been marked.
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)
NET MIGRANTS*
MIGRANTS – 1981 (in thousand)
NET OUTGOING
NET INCOMING
4000 – 5000
3000 – 4000
2000 – 3000
1000 – 2000
500 – 1000
0 – 500
* Net figures are the differences between outgoing and incoming migrant population from one state to another
N.A.

Fig- 5.8

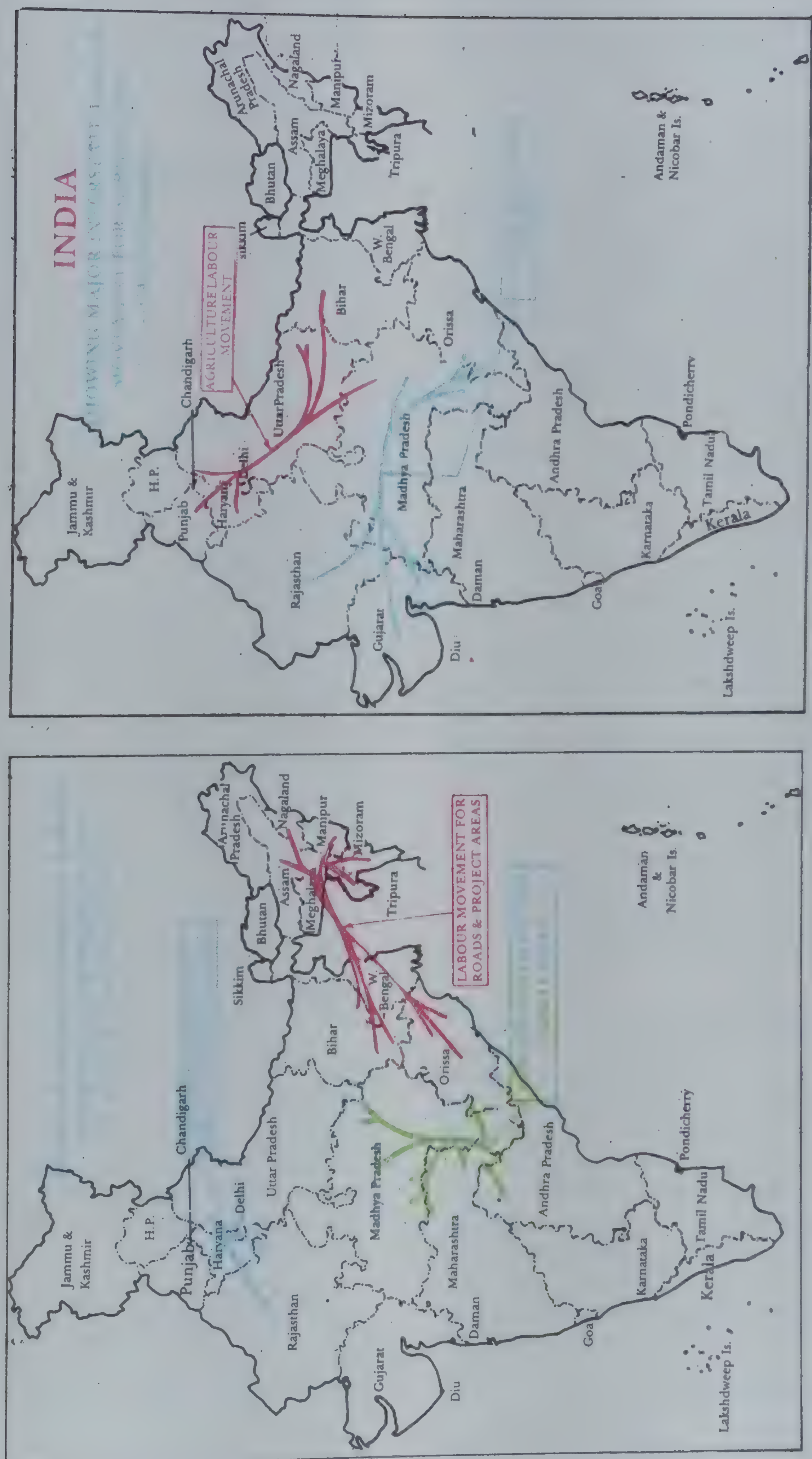

INDIA
AGRICULTURE LABOUR MOVEMENT
LABOUR MOVEMENT FOR ROADS & PROJECT AREAS
Jammu & Kashmir
H.P.
Punjab
Chandigarh
Haryana
Delhi
Uttar Pradesh
Rajasthan
Gujarat
Diu
Daman
Madhya Pradesh
Maharashtra
Bihar
Sikkim
Bhutan
Arunachal Pradesh
Assam
Nagaland
Manipur
Meghalaya
Mizoram
Tripura
W. Bengal
Orissa
Andhra Pradesh
Pondicherry
Tamil Nadu
Karnataka
Kerala
Goa
Lakshdweep Is.
Andaman & Nicobar Is.

Fig- 5.9

townships and carry back the finished goods to other parts of the country. The labour moving with the transport is exposed to unabated transmission of malaria when they halt at night during their journeys.

e. Malarial Transmission at Work Site

In industrial areas, apart from temporary labour force, the workers engaged in the industry especially those industries which are located in backward areas are more exposed to malaria transmission at the site of their working environment during night shift as compared to their families and others staying indoors in the industrial housing complex.

f. Movement of Military and Paramilitary Personnel

The other examples of occupation related human migration are movement of military and paramilitary forces from non-malarious areas to malarious areas and vice-versa. This is a mixed population having wide variations in the immune status of individuals against malaria. When they move to a new location, they are exposed to local strain of malaria and sometimes experience high incidence of malaria infection. The temporary nature of movement and the living conditions in difficult, hilly terrains of malarious areas expose this population to intense transmission. In such situations, the transmission interruption measures like spraying, etc. are difficult to implement. The personal prophylaxis is usually practised with variable results.

g. Labour Movement for Execution of Projects

The tropical aggregation of labour for construction of roads and canals is another example of occupation related malaria. Unlike the construction of dams and urban areas where labour force is aggregated in small camps surrounding the construction sites, road and canal construction labour is linearly spread over long distances. They intermingle with local population and focal outbreaks in a large number of villages are observed.

h. Human Movement for Fishing

Fishermen from the coastal areas of Western and Eastern Ghats transmigrate in the coast in the course of fishing expedition. During this period, they are exposed to local transmission when they dock in areas away from their homes. The epidemics have been recorded in Kerala and Tamil Nadu coastal villages which were started by fishermen returning from fishing trips.

i. Inter-country and Intra-country Movement and Resettlement of Repatriates

The year 1947 witnessed a great upheaval of population in the Indian sub-continent. With the formation of Pakistan, there was an exchange of population between both western and eastern sides. In the process, millions of persons crossed border to enter into India. These persons were first settled in small as well as big transit camps such as Mana camp in Madhya Pradesh. Later Government of India took a decision to resettle this population in different parts of the country and the job was entrusted to a separate 'Ministry of Rehabilitation'.

During the Chinese occupation of Tibet in 1959, along with His Holiness Dalai Lama, 80,000 Tibetan refugees spread to 10 Indian States and were resettled in colonies.

Later on, a large number of repatriates came to India from occupied Kashmir, Burma, Sri Lanka, Uganda, Mozambique, Zaire and Vietnam and their resettlement was done on similar pattern - from transit camps to settlement colonies. The 1971 Indo-Pakistan conflict again started the influx of refugees from East Pakistan - now Bangladesh to Assam, West Bengal and Tripura.

According to 1964 and 1974 agreements between the Govt. of India and Govt. of Sri Lanka, 0.6 million persons from Sri Lanka were granted Indian citizenship and a large number of these persons were rehabilitated in the country.

Recently there has been a large scale movement of thousands of persons from Kashmir, a non-malarious area to plains of India. They are still in transit camps.

Based on the experience on colonisation in UP Terai areas, the scheme of relief of rehabilitation was implemented directly by the Government of India as well as through State Governments. The Rehabilitation Authority was also set up in Jammu in 1974 to rehabilitate people displaced from Chamb. Apart from major resettlement projects, small schemes: two in Maharashtra, one each in

Karnataka, Andhra Pradesh, Andaman & Nicobar Islands, Orissa and Assam and five in Madhya Pradesh, were set up for settlement of new migrants in agricultural and other fields of activities.

. It is not possible to discuss the entire resettlement process occurring over a span of the last four decades, as well as the impact of population influx on malaria in the country.

Parasite Factors

The malaria parasite has two distinct life cycles:

i. In man

ii. In mosquito.

It will suffice to say that the development of asexual cycle in man, its duration and course of infection are determined by the genetic composition of malaria parasite. The malaria parasite in the human body grows in a protected environment, which is not affected by the factors like climatic changes such as humidity, temperature, etc. as well as adverse effects of other factors to which the extrinsic cycle of malaria parasite is exposed. Its development in man during the pre-erythrocytic phase, persistent tissue phase and duration of development of hypnozoites are the exclusive phenomena controlled by genetic attributes of the parasite. In *P.vivax* different strains have been identified where the clinical manifestation and relapse pattern are modified by the behaviour of *P.vivax* hypnozoites in the human body. Such variations are not present in case of other malaria parasites.

Parasite Invasion Dependent on Age of RBC

The difference in parasitaemia levels observed in *P.vivax* and *P.falciparum* are attributed to the fact that *P.vivax* tends to invade younger RBCs while *P.falciparum* invades all RBCs irrespective of their age. That is why the parasitaemia levels in *P.falciparum* are very high as compared to infections with other malaria parasite species.

The parasitic load in the peripheral blood and the gametocyte production are influenced by development of immunity in human host. These phenomena have been studied extensively. These observations have limited role in influencing the choice of malaria control technology. However they do modify response of host and parasite to antimalarials and to that extent it is important while selecting chemotherapeutic measures for obtaining a clinical and parasitological cure in malaria patients.

Factors Related to Vector(s) of Malaria

The malaria transmission in an area is dependent on frequency of man-vector contact. Greater the frequency of man-vector contact, higher will be the transmission potential of the area. The man-vector contact is influenced by a large number of variables. These are:-

i. Vector density.

ii. Flight range.

iii. Feeding habit; Frequency of blood meal.

iv. Biting habit.

v. Resting habit.

vi. Biting time.

The **mosquito densities** are dependent on availability of suitable larval habitats. In India, *An.culicifacies* is distributed all over the country and is considered to be the major vector of rural malaria. It breeds in ground water collections. The size and number of ground water collections fluctuate over a wide range. During rainy season, breeding places are numerous, hence the vector densities of *An.culicifacies* are at their peak at this time. The other important vectors of malaria are *An.minimus*, and *An.fluviatilis*. They breed in running channels with clear water, although *An.minimus* can tolerate some turbidity but not organic pollution. Therefore the densities of *An.minimus* and *An.fluviatilis* reach the peak just after the monsoon season when streams and channels have clear water and water velocities are low along the channel margins. The vector *An.dirus* breeds in a variety of permanent and temporary water collections in forest areas and tolerates organic pollution in the water body. Therefore, its densities are higher during rainy season. The vector *An.stephensi* in urban areas breeds in man made water containers such as tanks, overhead tanks, cisterns, etc. These larval habitats of *An.stephensi* are more or less of a permanent nature. Therefore, *An.stephensi* can keep appropriate densities for malaria transmission throughout the year. The identification and accurate enumeration of larval habitats of each

vector species are essential components of transmission dynamic studies.

Flight Range

The distribution and dispersal of vector species depend on their flight range. The flight range of mosquito is responsible for its vectorial influence in the area.

The focality of malaria transmission is directly associated with flight range of vector mosquito of the area.

An.fluviatilis, *An.minimus* and *An.culicifacies* are strong fliers and transmit malaria over a wider area. On the other hand, *An.dirus* has a shorter flight range and maintains malaria transmission within 1/2 a km of its breeding place.

Feeding Habits

Feeding habits determine that how often a single mosquito during its life may come in contact with man. The periodicity or frequency of blood meal is determined by the length of gonotropic cycle of vector species. The duration of gonotropic cycle is usually 2-3 days, but even a small variation introduced by temperature gradients of the locality can have profound effect on malaria transmission. Such variations are usually quite small, 6-8 hours, but they increase the frequency and pattern of man-mosquito contact. Sometimes at a very low temperatures the gonotropic cycle is prolonged up to twice the normal period.

Biting Habits

Anthropophilic index gives the proportion of vector population coming in contact with man. Biting habits of the mosquitoes described as anthropophilic and zoophilic depend on how often and in what proportion they bite on human beings or animals residing in the area. Anthropophilic index determined by precipitin and other tests gives a pointer to the proportion of mosquito population coming in contact with man in a given area. Those vectors which feed indiscriminately on cattle or human beings, for example *An.culicifacies*, the man - mosquito contact is reduced if in an area large number of cattle are introduced or increased. If cattle are removed or man cattle ratio is reversed, then the vector will seek human host more frequently for blood meal. *An.minimus*, *An.fluviatilis* and *An.dirus* are usually highly anthropophilic and only in the absence of human host, they are diverted to other hosts in the vicinity. For example, *An.dirus* a forest species although highly anthropophilic may feed on other primates in the absence of man. Studies have shown that *An.fluviatilis* is anthropophilic, endophagic and endophilic at 100 metres above MSL but zoophilic, exophagic, and exophilic at 600 metres above MSL in the same forested hill of Bastar District of Madhya Pradesh. *An.minimus* has been described as exophagic/endophagic but highly anthropophilic in different studies, although it also bites other animals in the area and a small proportion of vector population is considered as zoophilic. The results of these investigations show variations in the feeding habits of the same vector within a small area. This observation has led the entomologists to postulate that there may be several genetically variant sub-species of these vectors which are morphologically indistinguishable. The end result is that a lot of confusion exists on biting habits of vectors which is not resolved easily.

Resting Habits

All vectors of malaria in India like *An.culicifacies*, *An.fluviatilis*, *An.minimus*, and *An.stephensi* are indoor resters, but *An.dirus* is known to be outdoor rester. This habit of the vector species influences the impact of indoor residual insecticidal spray on the transmission control in the locality.

The exophilic and endophilic studies suffer from personal bias of the investigator such as time of indoor/outdoor collection and placement of light traps and their distance from human dwellings or cattle sheds.

Biting Time

Biting time of each vector species is determined by its genetic character, but can be readily influenced by environmental conditions. Most of the vectors like *An.culicifacies*, *An.fluviatilis* and *An.minimus* start biting soon after dusk. Therefore biting starts much earlier in winter than in summer but the peak biting time varies from species to species. On the other hand, *An.dirus* starts biting at 10 p.m. and peaks are reached later on during the night between 1 a.m. and 3 a.m. This will be discussed in detail when malaria transmission dynamics of different paradigms are described.

The biting time influences the time and place of man-vector contact which is sometimes modified by human bionomics.

The late biters will definitely enter the human dwellings where majority of human population sleeps but early biters come in contact with human host outdoors before the man sleeps indoors.

Environmental Factors

Among the environmental factors, 'abiotic' and 'unstable' components of the eco-system are the most important determinants of periodic fluctuation in malaria transmission, its duration and intensity as they frequently change from season to season and year to year.

The unstable components are temperature and rainfall. The temperature gradients of an area determine the length of the extrinsic cycle of malaria parasite and in turn, it is the deciding factor whether the mosquito will become infective or not over a given period of time.

The temperature gradient of a place decides whether malaria will be transmitted or not and if so during which period of the year.

It is generally believed that malaria transmission at heights above 5,000 ft. MSL is unknown. It is not the altitude of the place which determines whether malaria transmission will take place or not. What determines whether there will be malaria transmission or not is the temperature. In areas where mean temperature is below 16° C the sporogony cycle in vector is not completed. Between 16° - 20° C it is prolonged and vector may not survive long enough to become infective.

This temperature range should not be confused with mean temperature recorded in the ambient environment, but this mean temperature is applicable to micro-climate in the resting places of the mosquitoes.

The vector is poikilothermic i.e. it has no temperature control; its body temperature always fluctuates with the atmospheric temperature of the micro-climate of its resting place. The low body temperature of the vector also influences the metabolic system of the parasite and retards/ prolongs the development of different stages of parasite in the mosquito body.

1. Humidity

The dry air current of moderately high temperature reduces the longevity of the mosquito and the insect dies due to desiccation. High humidity levels prolong the life of the mosquito even in an environment having moderately high temperature. High humidity in the air current prevents desiccation of the mosquito. On the other hand it may also be true that very high humidity levels will have restrictive action on the flight range of the mosquito due to air drag exerted by dense air. Therefore, only those populations of the vector mosquito, which breed within the vicinity of the human dwellings will come in contact with man and transmit malaria.

2. Aerodynamics

Although there are hardly any studies on this aspect, it may be postulated that a fully fed mosquito becomes aerodynamically unstable and after a blood meal tends to rest in the nearest resting place till the meal is partially or completely digested. Afterwards it can fly away and rest outside. It has been observed that *An.dirus* which is a poor flier leaves the human dwelling immediately after blood meal. This is possible because full blood meal of *An.dirus* is nearly 1/3rd of what is taken by *An.minimus*. This aspect has not been well established and requires further investigation so that impact of blood meal on flight characteristics and resting habit of the mosquito can be considered while formulating a vector control strategy.

3. Rainfall

Rainfall is one of the crucial factors which provides extensive breeding places to vector mosquitoes. The rainfall pattern like the amount of precipitation, number of rainy days and distribution of rainfall over a season determines the number and extent of breeding places created for vector mosquitoes. The absence of rainfall precipitating drought conditions in an area results in pooling of water in river beds, streams and ponds creating large number of breeding places for *An.culicifacies* which breeds in ground water collection. Thus drought conditions can also start a focal outbreak of malaria in an area where *An.culicifacies* transmits malaria. On the other hand, heavy

rainfall creates strong currents in streams i.e. in breeding places of *An.fluviatilis* and *An.minimus*, the existing larvae are washed away, thus temporarily reducing densities of these vectors.

4. Other Environmental Factors

Apart from the 'unstable' and 'abiotic' factors discussed above, the other environmental factors like altitude, soil characteristics and geographical contours of an area also have impact on malaria transmission. Most of these features are more or less of permanent nature and are **stable**. They are usually not altered significantly, unless large scale human activity for development projects requires huge earthwork which is likely to change the natural contours of the area and its natural drainage gradients. These activities may also result in water logging of the area.

The soil types, its permeability, land relief and altitude in a locality are difficult to manipulate even by a large scale human activity. These are mostly permanent features of an area and have profound impact on transmission potential of the area. Thus while determining the transmission dynamics of the area, these features should be taken into consideration. The soil characteristics of a locality will determine how soon the rain water percolates down. In other words how long the rain water will remain patent in small pools to provide mosquito breeding places. In water logged areas, the movement of sub-terrain water streams is slow and the rain water does not seep readily into sub-soil. Therefore, large number of patent breeding places remain over a longer period of time.

The forest cover of an area also has impact on malaria transmission by virtue of keeping humidity levels at a high level resulting in long survival of all vector mosquitoes irrespective of the species concerned.

5. Land Relief

The geographical relief of an area characterised by foothills with thick vegetation, foothills without vegetation, foothills having steep slopes, undulating terrain with natural adequate or deficient gradient for run off water, plain areas and the type of soil also do have profound effect on malaria transmission.

The reasons have been already discussed above and they are usually taken into consideration while determining the transmission dynamics of the area. All these are almost permanent features of an area and are not easily manipulated or modified on a large scale as a part of malaria control activity. They are only considered as regards to their epidemiological impact on malaria transmission but they cannot be utilised for large scale control activity.

VECTORIAL CAPACITY

Most malariologists hold that 'vectorial capacity' as calculated by Garret John's equation plays 'the vital role' in malaria transmission dynamics. As mentioned earlier, apart from other factors 'vectorial capacity' is largely dependent on 'vector density per man' which in turn is influenced by factors like proximity of breeding places to human community; their number, size, and how long they remain patent. As already given above, biting habits of the vector and its anthropophilic habits are equally important determinants. The breeding places change from season to season and even day to day. Therefore it must be realised that very wide fluctuations will be recorded in the same locality in 'vector density per man' from day to day.

In spite of these limitations, 'vectorial capacity' is still used to estimate transmission dynamics.

However the Malaria Research Centre (MRC) of Indian Council of Medical Research (ICMR) has observed that 'vectorial capacity' in local human population shows a very high positive correlation with infection rates like Slide Positivity Rate (SPR) and Infant Parasite Rate (IPR) in the locality.

Parameter	Value	Remark
VC vs SPR	0.79	Although MRC has validated
VC vs IPR	0.76	this, if considered
VC vs SfR	0.74	necessary, this may be
VC vs CPR	0.52	further confirmed.

(Source: MRC Annual Report 1989)

Therefore, it stands to reason that instead of the 'vectorial capacity' the SPR can be substituted and used for malariogenic stratification. It is further apparent that if SPR is used, there is no need to use API as a parameter in malariogenic stratification. This assumption can be substantiated by considering how

some of the parasitological parameters are calculated.

$$\text{ABER} = \frac{\text{Numbers of blood smears examined in a year}}{\text{Total population under surveillance}} \times 100$$

$$\text{API} = \frac{\text{Total number of blood smears positive for malaria parasite in a year}}{\text{Total population under surveillance}} \times 1000$$

$$\text{SPR} = \frac{\text{Total number of blood smears positive for malaria parasite}}{\text{Total number of blood smears examined}} \times 100$$

Note:- The total population is a common denominator in ABER and API.

The population figures in the year used for calculating both ABER and API are same. Number of blood smears examined in a year may suffer from serious limitations which will adversely affect API. During the rainy season, which is also the transmission season, some of the house visits may be missed due to communication difficulty or only partial coverage of population may be achieved during this period. This results in low blood smear collection (low ABER). Consequently less number of positives are detected, and total positives in the year will be less. Thus API is influenced negatively i.e. low API.

On the other hand even if less number of blood slides are collected in the situation as described above, the period being transmission season, the number of slides found positive among these blood smears will be higher. Thus the SPR will be influenced positively i.e. higher SPR.

An analysis of data of the last three decades from India and different States, Union territories and all the districts in the States shows that:

i. When ABER, in any area, irrespective of its malaria prevalence ranges between 9 and 11%, the API and SPR have more or less similar values. The difference, if any, is not statistically significant.

ii. When ABER is less than 10%, SPR is higher than API and at 5% ABER, it is twice that of API. At further lower levels of ABER - 2.5% or below, SPR is four times or more as compared to API.

iii. When ABER is above 12% but less than 15%, the API is 20-50% more than SPR. When ABER reaches nearer to 20%, the SPR is nearly half that of API.

iv. In some cases when ABER moves up beyond 25 or 30%, the API as well as SPR may show slightly lesser increase except in endemic areas.

v. As children and pregnant mothers suffer most with malaria, it will be worth while to use age & sex-wise SPR instead of composite SPR.

vi. In some quarters it is mooted that S*f*R and S*v*R should also be taken into account along with SPR. As this technique is quite complicated and expertise is not presently available at field level, it may not be possible to adopt these parameters. However, as and when an optimally trained manpower is available, this technique should be taken up for validation.

It is true that even in lowABER areas SPR will show the malaria picture nearer to the actual situation while API calculated with the same data will show lower figures which are slightly farther from the real situation.

Thus a major departure suggested is the use of SPR instead of API which will more or less compensate for low ABER recorded in some areas.

It may be clearly understood that apart from SPR, all other parameters utilised in malariogenic stratification, combined together only shape an 'environmental situation' which supports or produces a specified level of SPR which in turn reflects the malaria incidence in the area. It will be better if an average SPR for transmission months is used instead of annual SPR.

The data can be analysed and utilised for evaluation of programme objectives. If analysis is carried on age-wise SPR and S*f*R, it will indicate that in spite of programme implementation, certain specific age groups are more vulnerable to malaria during certain period and the programme activities may be modified to give better coverage to this section of population at particular point/period of time during the year.

If adequate manpower is available for record analysis under the Primary Health Care System (PHC), month-wise records of Slide Positivity Rate (SPR) and Slide *falciparum* Rate (S*f*R) of the Passive Case Detection agency (PCD) should be maintained separately. Use of PCD, SPR and S*f*R is suggested because the slide positivity in fever

cases reporting to a PCD facility at PHC or dispensary is always much higher than the slide positivity rates observed in blood smears collected through Active Case Detection (ACD) mechanism.

It is also realised that at this stage very large manpower will be required to calculate the average SPR for transmission period for all PHCs or Sections. On the other hand annual SPR is one of the routine parameters calculated by NMEP at field level and is easily available for all PHCs or Sections/Subcentres of the country.

Before attempting an epidemiological study of transmission dynamics of a malaria paradigm, it is essential to choose only those parameters which can be worked out from field level data or the data required can be generated by the field staff within a short period of time. The attributes of data may be:

a. Take only those records which are easily available with the programme or allied organisations.

b. Parameters likely to have primary impact on transmission dynamics in the locality.

These can be classified as:-

i. Of permanent nature which cannot be manipulated;

ii. Of permanent nature which can be manipulated;

iii. Of unstable nature changing over a period of time but can be compensated.

iv. It is suggested that when cluster analysis technique for malaria is developed and perfected in future, it should be used for stratification in Indian programme.

v. Multifactorial analysis is difficult to apply in case of malaria as almost all environmental factors are not quantifiable in terms of their relative contribution to malariogenic potential of the area but whenever this technique is perfected, it can be very profitably used to study malaria transmission.

SOME GREY AREAS OF TRANSMISSION DYNAMICS

A few phenomena which are not clearly understood indicate that both vector as well as parasite attributes combined together exert pronounced effect on transmission dynamics of the area. These are discussed below:-

Duration of Extrinsic Incubation Period

For example *An.stephensi* is a very efficient vector of malaria. Nearly 44 per cent of them show positivity under laboratory conditions. Sporozoite positivity ranges from 20 to 86 per cent in different experiments. In India, *An.stephensi* does not transmit malaria with the same intensity in different parts of the country. There are many reasons for this. Under laboratory conditions, it has been observed that the duration of extrinsic or sporogony cycle of *P.vivax* in *An.stephensi* differs in different parts of the country. In Northern India, i.e. Delhi, the cycle is of about 8 days, while in Southern India i.e. Madras the duration of the sporogony is longer by 3 to 4 days. Whether this difference in the duration of sporogony is due to characteristics of different strains of *P.vivax* or *An.stephensi* is under further investigation but there is a definite difference in transmission dynamics of malaria by *An.stephensi* in these two areas of the country. While in Southern India, explosive outbreaks of malaria due to *An.stephensi* are rare, in North and North West India, explosive outbreaks of malaria have occurred during this century in towns like Lucknow, Bombay and Delhi. Recently in arid rural areas of Rajasthan, under the vectorial influence of *An.stephensi* explosive epidemic of malaria causing high mortality was recorded in 1994. Out of a large number of variables governing the explosive nature, intensity of an epidemic may be attributed to the variations in the duration of extrinsic cycle of *P.vivax* and probably of *P.falciparum* also in *An.stephensi* in different parts of the country. Further details will be discussed while describing transmission of related malaria paradigm.

An.culicifacies is complex of sibling species.

In experimental studies, it has been demonstrated that sibling species A and B when fed simultaneously on the same gametocyte carrier, there was a vast difference in number of oocysts developing on the stomach of the sibling species. The sibling species A was found to be studded with many oocysts while in sibling species B, only one oocyst was observed. These experiments were carried on sibling species found in northern plains of India, while sibling species B is found to be a good vector in Rameswaram Island. It is now postulated that this may be a variant of species B and not similar to the sibling species B found in northern plains. However, sibling species identification is difficult and requires special technique. How effectively this phenomenon can be utilised in planning control operations in an area is not yet clearly understood.

There are many other aspects of similar nature observed by malariologists all over the world which require careful investigations so that correct interpretation of these phenomena can be made and applied in the field of malaria control. The description and listing of these subjects are outside the scope of the present book.

SECTION-3
TRANSMISSION DYNAMICS IN DIFFERENT PARADIGMS

In the present section of this chapter, transmission dynamics of different malaria paradigms are discussed. The general approach is directed towards discussions on various facets of transmission dynamics which help in choosing a technical approach to malaria control operations in the concerned paradigm.

The most important aspects of malaria transmission are 'TIME', 'PLACE' and 'FREQUENCY' of man-mosquito contact. These determine where an infective mosquito will bite a person and disseminate the malaria infection. To study these three aspects of vector bionomics, a malariologist should gather data of parameters such as i). fluctuations in vector density at weekly / monthly intervals, ii). proportion of nulliparous and parous mosquitoes, iii). biting preference of vector species as ascertained by blood meal analysis, iv). the biting time studies undertaken on human and animal baits both outdoors (at least 50 to 100 metres away from human dwellings) and indoors. This study gives anthropophilic and zoophilic indices of vectors, its endophagic, exophilic behaviour as well as its endophilic/exophilic behaviour. These important aspects will determine which control measure will be most appropriate for malaria control in the area.

Those Malariologists who are interested in other aspects of transmission dynamics in an area are advised to look up the literature in other text books on malaria reproduction rate and vectorial capacity of different vectors of malaria.

Longevity of the vector is to be ascertained by the parity rate (alternatively the proportion of nulliparous and parous). Age analysis can also be obtained through study of blood meal status, i.e. unfed, fed, half gravid and full gravid).

Another important facet of transmission dynamics is the socioeconomic status of the community. The type and location of dwelling, occupation of the host, the sleeping habits and personal prophylactic measures play a pivotal role in the transmission dynamics. To ascertain the impact of the above aspects on transmission dynamics, studies should be undertaken in different malaria paradigms to know the age-wise and sex-wise distribution of malaria parasite *vis-a-vis* socioeconomic status and human behavioural aspects.

The above studies will enable the programme managers to modify the transmission intervention measures wherever warranted.

INTRODUCTION

A paradigm usually connotes a 'MODEL SITUATION'. A malaria paradigm can be described as a specific situation supporting a level of malaria endemicity dependent on local environmental conditions and human socioeconomic activities. In many textbooks and monograms on malaria, malarious conditions associated with different occupations, topography and ecological conditions have been given popular names such as Tribal malaria, Foothill malaria, Forest malaria, Agricultural malaria, Project malaria, Gem mining malaria, etc. These names emphasise the correlation of malaria endemicity with a particular human activity. For example, **'agricultural malaria'** associated with agriculture practices is not same everywhere. The endemicity levels, transmission potential, local vectors of malaria and also other factors responsible for malaria transmission differ from one agricultural community to another. Therefore, agricultural malaria cannot be described as a single paradigm of malaria.

A large number of malaria paradigms can be identified on the basis of human socioeconomic activities and climatological conditions of the area. Usually the climatological conditions determine which one of the many malaria vectors present in the country will transmit malaria in the locality. The human socioeconomic activity and vector bionomics determine the time and place of man-mosquito contact.

Intensity of malaria transmission in a locality is usually determined by frequency of man-mosquito contact.

For example, in rain forest area, where the principal vector is *An.dirus*, the man - mosquito contact usually takes place within 100 metres of the breeding place of *An.dirus* because this vector is a poor flier. Although its dispersal range is much wider (up to 0.8 to 1.6 km), yet the dispersal range of the vector does not have the same importance in influencing malaria transmission as the flight range. **In case of *An.dirus* the man-vector contacts start at 10.00 p.m. and between 1 a.m. and 3 a.m. Therefore, the point of man-mosquito contact and its time are at the sleeping places of the human host after midnight.**

During World War II, prior to the use of DDT for malaria control in the Army, in North-Eastern States of India, the allied forces going to Eastern front were instructed to stay in the **'safe places'**. The **'safe place'** was a clearing of 2 miles in diameter in the middle of the rain forest of the North-Eastern States of India. The troops were stationed in the centre of this clearing to avoid man-mosquito contact i.e. contact between troops and *An.dirus* as the centre of the clearing was beyond the flight range of mosquito. Thus a fair degree of malaria control was achieved in these troops.

MAN MADE BREEDING PLACES

Human behaviour also results in increased mosquitogenic conditions in and around the human habitation. In Rajasthan, because of scarce water resources, the local population stores rain water for domestic use in big underground tanks. These underground tanks are ideal breeding habitats of *An.stephensi* and local transmission occurs quite frequently. Fluctuations in malaria incidence are observed in different localities and also in the same locality from year to year because of variations in maintenance of these water tanks by the house owners.

PARADIGMS IDENTIFIED BY EXPERT COMMITTEE IN INDIA

The Expert Committee on Malaria appointed by Government of India - 1995 has identified some paradigms of malaria but these areas do not have uniform transmission dynamics. There are large number of pockets with various grades of malariogenic potential.

TRIBAL AREAS

The forest types in India are shown in Fig- 5.10

One of the paradigms identified was termed as **'tribal areas'.** The areas are spread over the seven North-Eastern States and tribal areas of Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Orissa and Rajasthan. **This paradigm is not a single entity** but is composed of many sub-paradigms depending on the human ecology and local climatic conditions as discussed hereunder.

i. Hilly Rain Forest - Vector *An.dirus*

The forested tribal areas of North-Eastern States are studded with rain forest. The rainy season is long- 200 to 250 rainy days per year. Rainfall is in

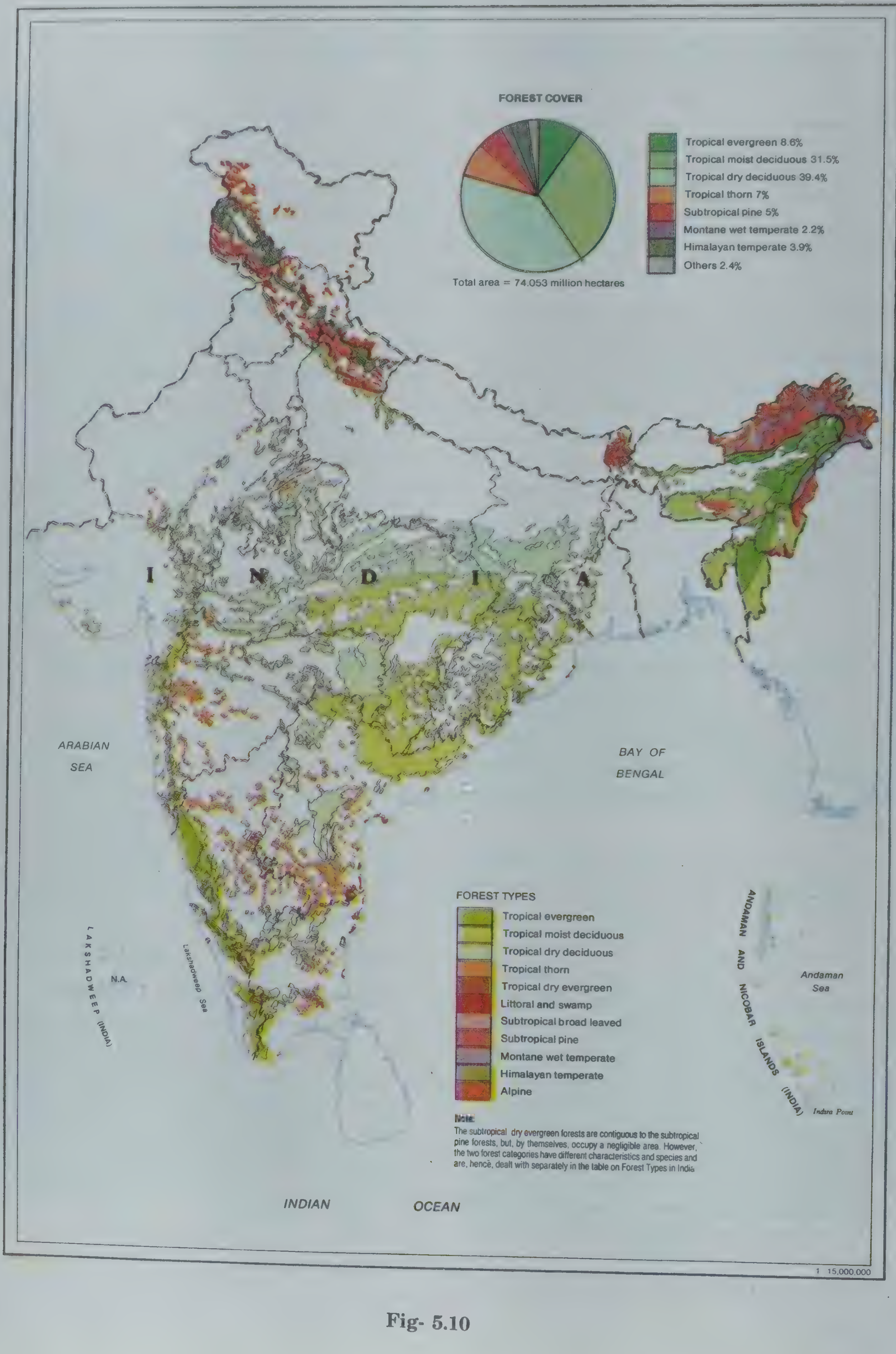

FOREST COVER
Tropical evergreen 8.6%
Tropical moist deciduous 31.5%
Tropical dry deciduous 39.4%
Tropical thorn 7%
Subtropical pine 5%
Montane wet temperate 2.2%
Himalayan temperate 3.9%
Others 2.4%
Total area = 74.053 million hectares
I N D I A
ARABIAN SEA
BAY OF BENGAL
LAKSHADWEEP (INDIA)
N.A.
Lakshadweep Sea
ANDAMAN AND NICOBAR ISLANDS (INDIA)
Andaman Sea
Indira Point
FOREST TYPES
Tropical evergreen
Tropical moist deciduous
Tropical dry deciduous
Tropical thorn
Tropical dry evergreen
Littoral and swamp
Subtropical broad leaved
Subtropical pine
Montane wet temperate
Himalayan temperate
Alpine
Note:
The subtropical dry evergreen forests are contiguous to the subtropical pine forests, but, by themselves, occupy a negligible area. However, the two forest categories have different characteristics and species and are, hence, dealt with separately in the table on Forest Types in India
INDIAN OCEAN
1 : 15,000,000

Fig- 5.10

the range of 4,000 mm to 8,000 mm or above per year, with relative humidity constantly 80% or above. Temperature is the only limiting factor in Himalayan ranges and the temperature drops below 16^0 C quite early in the winter season.

In this forest, the primary vector is *An.dirus*. This is the western limit of distribution of *An.dirus* in South East Asia, sibling species '7' of *An.dirus* is predominant in these hills (See Fig- 5.11). As already mentioned, it is a late biter. Man-mosquito contact occurs from 10 p.m. to 3 a.m. usually indoors. After a blood meal it rests outdoor; it is not a zoophilic species, it is not diverted to cattle but if human host is not available it feeds on primates living in forest areas.

In **tropical rain forests** where both *An.dirus* and *An.minimus* are vectors, malaria transmission becomes stable leading to hyperendemicity.

ii. Hilly Deforested Cultivated Areas - Vector *An. dirus*, and *An.minimus*

The distribution of *An.minimus* in South East Asia and India is shown in Fig- 5.12.

There has been extensive deforestation in this area due to Jhum cultivation and commercial exploitation connected with developmental activities. These deforested areas are under the vectorial influence of *An.minimus*, mostly at the fringes of the forest. This vector transmits malaria during post-monsoon season, while *An.dirus* at the forest fringe transmits malaria during peak of monsoon. These vectors transmit malaria in different months of the year and in some months both vectors are operative. This leads to a prolonged transmission period in forest fringes as compared to malaria transmission by a single vector in deep forest. Therefore, the malaria transmission and resultant **endemicity are of a very high order at the forest fringes when compared with malaria situation in deep forested areas in this region.** Every year the transmission in both places stops due to fall in temperature from October onwards. *P.falciparum* predominates during the later part of the year.

An.dirus, and *An.minimus*, are susceptible to commonly used insecticide- DDT. If indoor residual insecticide is properly sprayed during the transmission period, the malaria endemicity can be controlled and interruption of transmission can be achieved. Theoretically it appears that transmission control in villages which are close to the forest fringes where *An.dirus* transmits malaria, may not be possible by indoor insecticidal spray. *An.dirus* is an exophilic vector although a poor flier, but after taking the blood meal, it leaves the human dwelling to rest outside. This vector has least contact with insecticide sprayed indoors in human dwellings. It avoids such a contact on account of its habit of leaving houses immediately after blood meal. Why a poor flier like *An.dirus* leaves the house immediately in spite of its abdomen full of blood meal, while *An.minimus* a strong flier rests indoor on insecticide sprayed surface after blood meal is partially explained by the fact that the blood meal taken by *An.dirus* is 1/3rd in quantity as compared with the blood meal taken by *An.minimus*. Even after a full blood meal *An.dirus* is lighter in weight than *An.minimus*. After blood meal it is aerodynamically more stable than *An. minimus* and therefore it goes out of human dwelling.

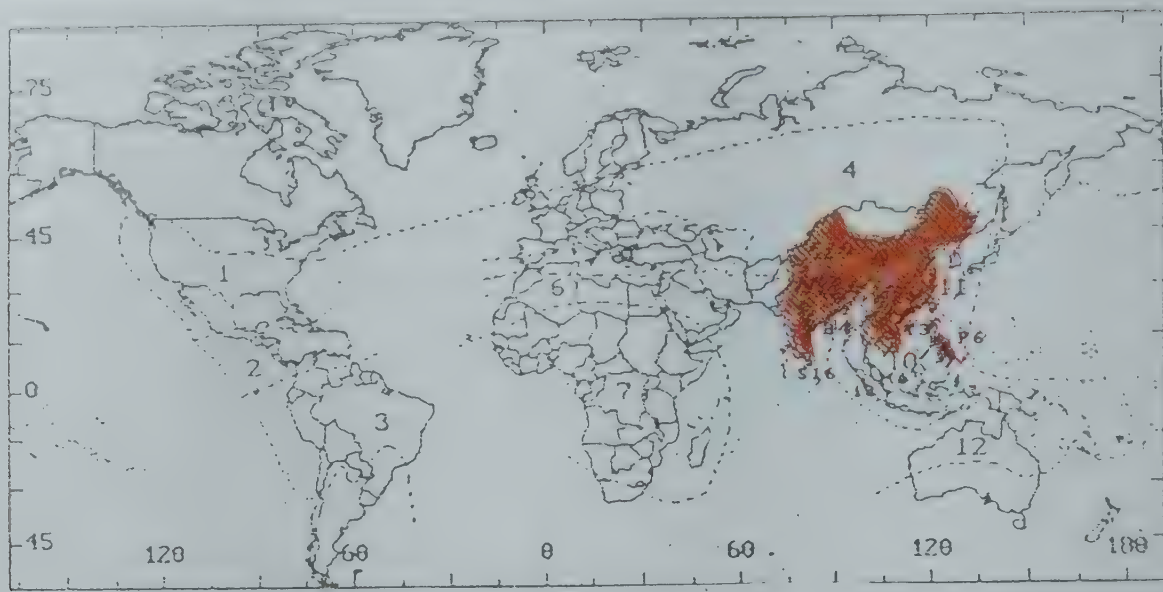
It is therefore, mooted that malaria transmission cannot be controlled by indoor residual insecticidal spray in areas under the vectorial influence of *An.dirus*. In many places it has been observed that in *An.dirus* areas wherever insecticidal spray coverage with insecticides was of a very high order and also the quality of spray was very good, transmission interruption or reduction was observed. *An.minimus* and *An.fluviatilis* are endophagic and endophilic. They rest inside the house to partially digest the meal before they fly out to rest outside. Thus they are exposed to insecticide for a much longer period resulting in interruption of transmission by these two vectors.

From the above analysis, it is evident that in North-Eastern States, there are three sub-paradigms of malaria namely:

a. Deep forest areas - in these forest tribal villages, labour camps for wood cutting and charcoal making, mining, etc. malaria transmission is influenced by *An.dirus*.

b. In forest fringe villages with agricultural land both *An.dirus* and *An.minimus* play an important role in malaria transmission. The malaria transmission is prolonged with intense malaria.

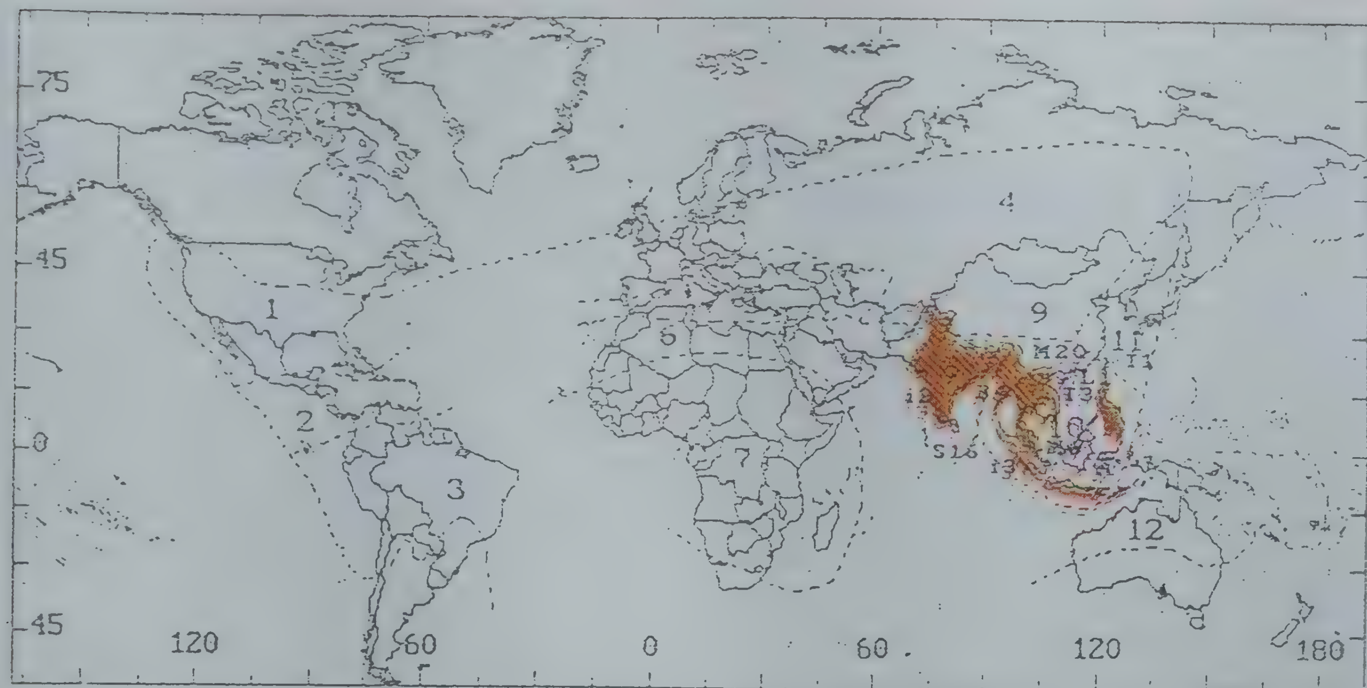
c. Undulating deforested areas with rice cultivation where malaria is endemic but having frequently wide fluctuations under the vectorial



Reported distribution of *An.dirus* in the world

Reported distribution of *An.dirus* in India

Fig- 5.11



Reported distribution of *An.minimus* in the world

Reported distribution of *An.minimus* in India

Fig- 5.12

influence of *An.fluviatilis* or *An.minimus* and *An.nivipes*

iii. Deciduous Forest in Peninsular Hills: Vector *An.fluviatilis* and *An.culicifacies*

On the other hand the hilly and forested areas of peninsular India are characterised by wet deciduous forest with comparatively lower rainfall and humidity levels. The rainy days are usually 33 to 63 per annum, the annual precipitation is 400 mm to 1,600 mm. The temperatures are conducive for the year round transmission except during months of December and January. In some areas the usual vector breeding habitats dry out (stream and other water collections) during March to May/June, and get filled up and flooded with the onset of monsoon. In these forests, the main vector is *An.fluviatilis* supported by *An.culicifacies* at forest fringes and agriculture land. *An.dirus* has no role in transmission of malaria in these areas due to low humidity levels. *An.dirus* requires very high humidity to attain adequate longevity levels to become infective (sporozoite positive) to support malaria transmission in the area. Therefore in spite of the fact that this species is found during mosquito collections, it is not considered a malaria vector in Peninsular India. In these areas malaria incidence fluctuates widely, causing sometimes epidemics.

Generally speaking there are two malaria paradigms in these hilly areas which are epidemiologically quite distinct when compared to rain forest of North-Eastern States.

a. Deep Forest Areas: Vector *An.fluviatilis*

An.fluviatilis plays a dominant role in transmission of malaria in these forested hilly areas. It is a highly anthropophilic, endophagic and endophilic vector. **Because of these features, intense transmission of malaria with high *P.falciparum* incidence takes place in the villages but only during the later part of the monsoon when the water bodies, where *An.fluviatilis* breeds, are not flooded** and the slow moving streams carry clear water.

b. Deforested Hilly Areas with Agriculture: Vector *An.fluviatilis* and *An.culicifacies*

In the areas cleared for agriculture near the forest fringes, the transmission is influenced by both *An.fluviatilis* and *An.culicifacies*. The transmission in these areas is very intense and *P.falciparum* predominates. *An.culicifacies* transmits malaria during monsoon while *An.fluviatilis* in the post-monsoon months. In these areas wherever all four sibling species - A, B, C and D are present, the malaria incidence is very high. While in the foothills & valleys on the Northern side of the peninsular hill ranges where only sibling species - A,B and C are present, malaria incidence is comparatively moderate/ lower; in the foothills of the Eastern & Western Ghats where *An.culicifacies* sibling species B & C or A & B or A & C are sympatric, the endemicity levels vary widely (Fig- 5.13).

In these areas, good control can be achieved by residual insecticidal spray in the villages where *An.fluviatilis* is the only vector, while in agriculture areas, undulating terrain, where both the vectors *An.culicifacies* and *An.fluviatilis*, transmit malaria, the transmission interruption is more difficult. *An.culicifacies* is usually resistant to DDT as well as BHC. **Blanket spray with residual insecticide is not likely to achieve same results as in forested areas.** Both these vectors start biting early and the peak is reached near midnight. The difficulty of achieving malaria control in these areas by indoor residual insecticide as well as use of impregnated bednets can be visualised. In these areas, both methods i.e. indoor spray and bednets combined will give better results if supported by water management techniques wherever feasible.

EPIDEMIC PRONE AREAS

The second paradigm identified by the Expert Committee was 'epidemic prone' areas. They identified areas of Punjab, Haryana, Western Uttar Pradesh, Rajasthan, Madhya Pradesh and a few pockets of other States. When these epidemic prone areas are examined and analysed, quite a few distinct malaria paradigms can be identified.

a. Semi-arid Desert Areas

Rajasthan can be taken as an example. It is observed that these epidemic prone areas have low rainfall ranging from 200 mm to 400 mm annually with an average of 20 rainy days per annum. The soil is porous and hence water does not accumulate but immediately seeps underground. In rocky terrain with thin soil cover, there are surface water streams which usually go dry during summer season. In other places, the rain and

Distribution of *Anopheles culicifacies* Sibling Species.

Courtesy : Dr. Sarala K. Subba Rao, Malaria Research Centre Delhi

Fig- 5.13

seepage water from adjoining rocky terrain accumulates and small lakes are formed which are quite frequently seen in semi-arid areas of Western India. In desert areas, where the soil cover is deep, the lakes are seldom seen. People in the area collect rain water for domestic purposes in underground tanks. The water supply is supplemented by deep step wells.

The culturable waste land along with waste land extent is given in Fig- 5.14

b. Semi-arid Desert Areas with Canal Irrigation

The recent development of canal irrigation system in the western districts of Rajasthan has resulted in augmentation of irrigation facilities for agriculture and has created an entirely new malaria paradigm in this semi-arid zone. In this zone after introduction of canal irrigation, the mosquito breeding habitats have increased. These habitats are created by pooling of water in the irrigation system. There are additional larval habitats supported by step-wells and domestic water collection in underground tanks. In this paradigm, the malaria transmission is mostly due to *An.culicifacies* (sibling species distribution is probably A and B) supported by *An.stephensi* which breeds in water containers. It has been observed that the sibling species A breeds more profusely in surface water collection in canal irrigation system. Depending on the local irrigation practices and accumulation of seepage water from canals, the number of *An.culicifacies* breeding habitats fluctuate. The malaria transmission in these areas is intense and fluctuates from year to year resulting in endemic conditions with superimposed cyclical epidemics.

c. Non-irrigated Semi-arid Areas

In desert villages where the water sources are limited to underground tanks and step wells, *An.stephensi* plays a predominant role in transmission of malaria. Although *An.culicifacies* breeding has been reported in wells in peninsular India, its breeding in wells in Northern India is rarely reported. The endemicity levels are not very high. They fluctuate from year to year, but epidemics do occur at cyclical intervals. In this situation implementation of antilarval measures in water storage tanks and step wells for control of malaria will give best results.

d. Ecosystem Supported by Lakes

In human habitation surrounding the lakes, malaria transmission is influenced by *An.culicifacies* alone. As the breeding surfaces are limited, the rain water seeps down quickly hardly leaving patent mosquito breeding sites on surface of the ground. The endemicity levels are variable, low to mesoendemic. The epidemics are rare. The water management and antilarval measures in the lakes, peri-domestic and domestic water bodies will control local transmission.

e. Epidemic Prone Alluvial Plains of Indo-Gangetic Area

The other States - Punjab, Haryana and Western U.P., were traditionally epidemic areas where devastating epidemics have been described in early decades of this century. However, the ecosystem has completely changed due to developmental activities; the area is mostly denuded of forest as vast areas have been brought under intensive agriculture. Over the last few decades the irrigation facilities have increased manifold. The soil in some of the areas has become waterlogged. The rain water does not percolate down as quickly as in the past, because the subsoil channels above the first impervious layer are waterlogged and the rate of water flow in sub-terrain channels is slow. In these areas, the pattern of endemicity has changed. Most of the areas which were epidemic prone for the last many years are recording higher incidence of malaria mostly due to *P.vivax* and have become meso-endemic. However, sometimes in the wake of unusual heavy precipitation and flooding, malaria epidemics do occur. The intensity and duration of epidemic depend on the time of heavy rainfall.

Rainfall Pattern Modifies Transmission Pattern

If the precipitation is heavy at the tail end of the monsoon season, the course of epidemic will be short-lived with smaller peak of cases with predominance of *P.vivax*. High malaria morbidity but low mortality are observed. The transmission is cut down because with the onset of winter the ambient temperature falls, the extrinsic cycle is prolonged and transmission ultimately stops. On the other hand, if there are early heavy rains in the month of May at the beginning of the monsoon

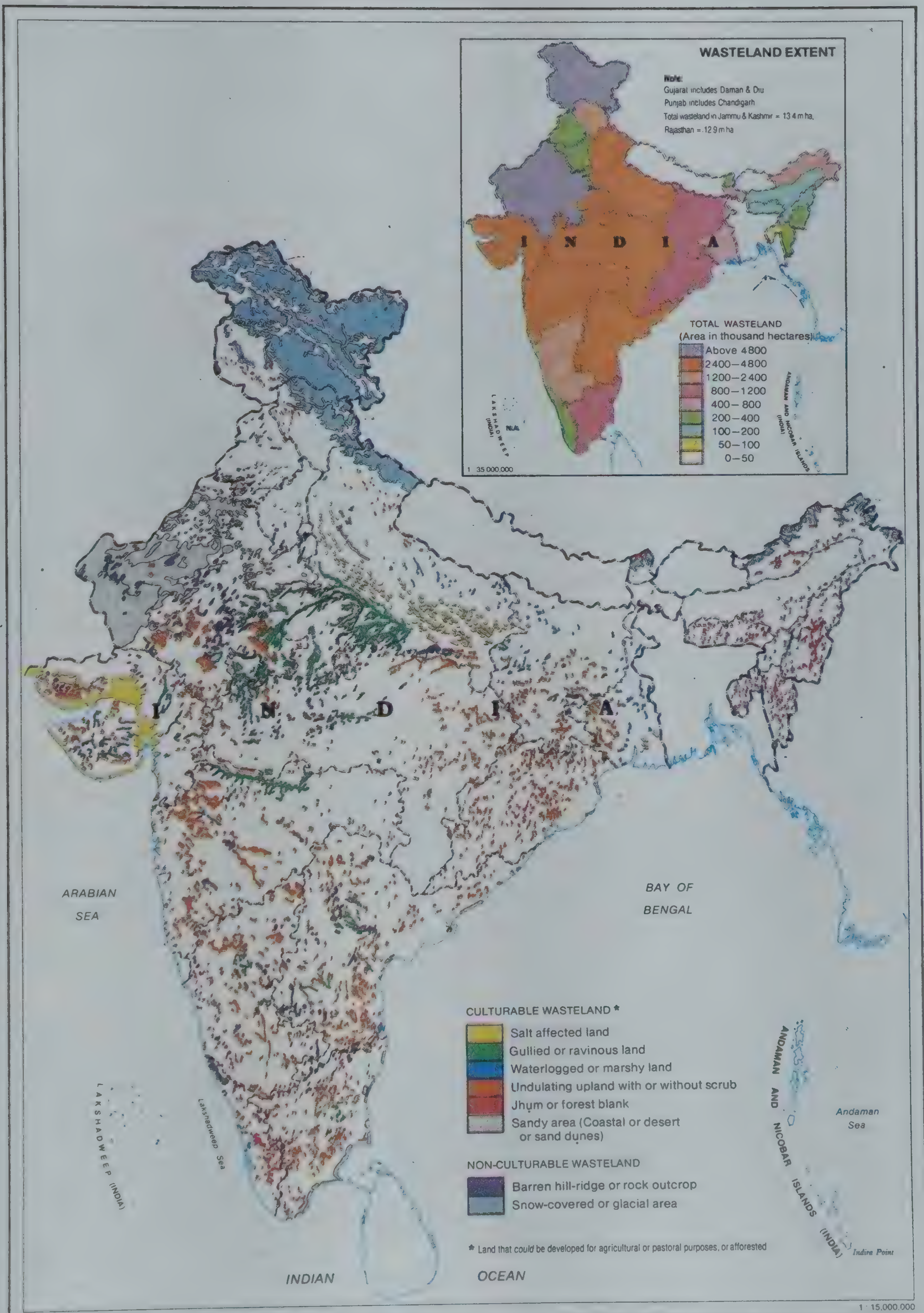

WASTELAND EXTENT
INDIA
TOTAL WASTELAND
(Area in thousand hectares)
Above 4800
2400—4800
1200—2400
800—1200
400—800
200—400
100—200
50—100
0—50
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)
1 : 35 000,000
INDIA
ARABIAN SEA
BAY OF BENGAL
CULTURABLE WASTELAND *
Salt affected land
Gullied or ravinous land
Waterlogged or marshy land
Undulating upland with or without scrub
Jhum or forest blank
Sandy area (Coastal or desert or sand dunes)
NON-CULTURABLE WASTELAND
Barren hill-ridge or rock outcrop
Snow-covered or glacial area
* Land that could be developed for agricultural or pastoral purposes, or afforested
LAKSHADWEEP (INDIA)
Lakshadweep Sea
ANDAMAN AND NICOBAR ISLANDS (INDIA)
Andaman Sea
Indira Point
INDIAN OCEAN
1 : 15,000,000

Fig- 5.14

season, the course of epidemics will be prolonged with high incidence of *P.vivax* and later *P.falciparum*. Out of the total incidence of malaria, *P.falciparum* usually will not overshoot total *P.vivax* incidence but its incidence will be high. The epidemic is characterised with bulk of positive cases being contributed by *P.vivax* with fair number of *P.falciparum* and sizable malaria mortality at the tail end of the transmission period. The transmission in these areas will also come to an end due to unfavourable temperature conditions which usually prevail during winter months. The vector, *An.culicifacies* is resistant to many of the insecticides used under NMEP and agriculture. The transmission control with residual insecticidal spray with traditional insecticides will be difficult. Newer or alternative insecticides can be used for epidemic control for a year or two. Later on the insecticidal spray can be withdrawn and the situation controlled through early case detection and treatment of malaria cases.

URBAN AND PERI-URBAN PARADIGMS OF MALARIA

One of the 'high risk' areas identified by the Expert Committee on Malaria-1995 was urban area. At present nearly 237 million population resides in urban areas of the country and account for 25.72 per cent of the total population. When the National Malaria Eradication Programme was launched in 1958, malaria was considered to be a major health problem in rural areas. During the first quarter of this century a few fulminating epidemics of malaria occurred in Bombay, Lucknow, etc. but by and large, the urban areas had much less incidence as compared to rural areas. Under NMEP, in rural areas insecticidal spray in human dwellings and cattle sheds was the sheet-anchor of malaria transmission control activities. In urban areas, malaria was much less and it was the experience that residual insecticidal spray was not readily accepted by the urban community. That was the reason why urban areas were not brought under residual insecticidal spray. In urban areas the breeding habitats of vectors were mostly man-made and of permanent nature. It was expected that antilarval measures with chemical larvicides and biological methods will control malaria transmission in urban areas. In some urban areas which had agriculture or grassland within the municipal limits, *An.culicifacies* supplemented malaria transmission by *An.stephensi* in these pockets. In the urban periphery, *An.culicifacies* transmits malaria. Considering the above, residual insecticidal spray was recommended in 1 km to 1.5 km of peripheral belt of urban areas. Later on, the surveillance activities were introduced in urban areas. In the built-up areas of towns and cities, antilarval operations were made the responsibility of local bodies. Unfortunately most of the local bodies could not cope up with the malaria problem, because of financial constraints, adequate antilarval operations could not be implemented. Some of the local bodies due to lack of funds abandoned antilarval measures which had been in operation earlier. The situation was made more complicated by rapid developmental and construction activities in urban areas. Unplanned rapid expansion of urban areas, industrialisation without proper drainage facilities and development of supporting infrastructure like rail and roads without keeping in mind the natural flow of surface water increased mosquitogenic conditions in all urban areas. The slums within the town and its periphery were the worst affected areas because of lack of water management and appropriate antilarval operations.

The urbaniation along with Class-1. Towns is shown in Fig- 5.15

Malaria in urban areas surfaced as a big problem in Tamil Nadu, Andhra Pradesh, Gujarat, West Bengal, Rajasthan and Maharashtra during 1963 to 1968. The problem was further aggravated by transmigration of population to urban areas. The rural unemployed came to urban areas in search of seasonal employment and on their return carried with them malaria infection to their native villages resulting in focal outbreaks.

Observing the steep rise of malaria incidence in urban areas in the late sixties, Urban Malaria Scheme was launched in 1971-72. Initially 22 towns were brought under this scheme. The scheme was implemented in towns having population of 40,000 and above with API 2 or more. At present 131 towns and cities in 18 States and Union Territories are under the Urban Malaria Scheme covering a population of about 74 million. The malaria problem in urban areas continues to be serious and requires immediate attention. With the Modified Plan of Operation, the surveillance operation in most of the urban towns was disrupted because urban areas do not come under

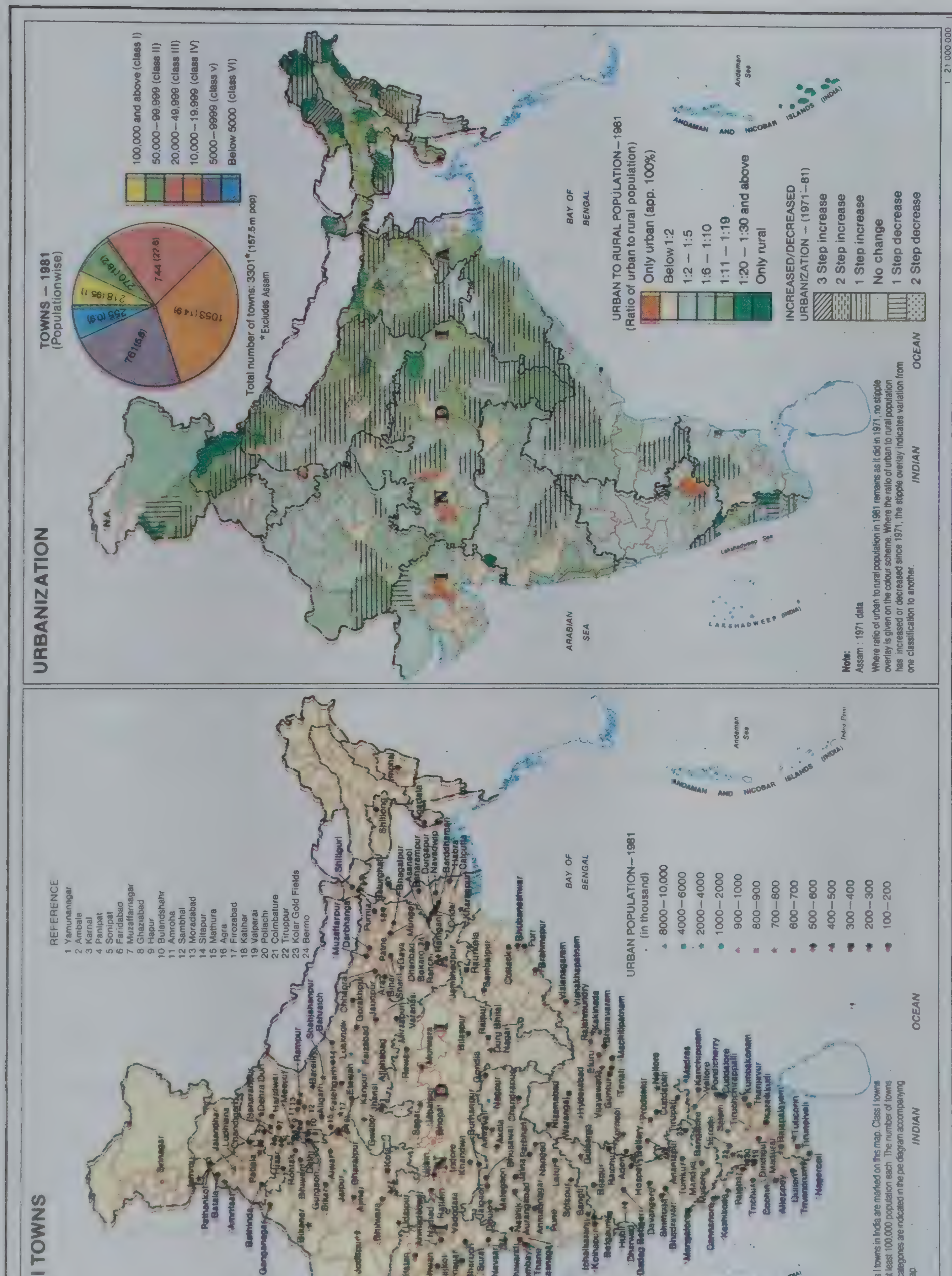

CLASS I TOWNS
URBANIZATION
TOWNS – 1981
(Populationwise)
100,000 and above (class I)
50,000–99,999 (class II)
20,000–49,999 (class III)
10,000–19,999 (class IV)
5000–9999 (class v)
Below 5000 (class VI)
URBAN TO RURAL POPULATION – 1981
(Ratio of urban to rural population)
Only urban (app. 100%)
Below 1:2
1:2 – 1:5
1:6 – 1:10
1:11 – 1:19
1:20 – 1:30 and above
Only rural
INCREASED/DECREASED
URBANIZATION – (1971–81)
3 Step increase
2 Step increase
1 Step increase
No change
1 Step decrease
2 Step decrease
URBAN POPULATION – 1981
(in thousand)
8000–10,000
4000–6000
2000–4000
1000–2000
900–1000
800–900
700–800
600–700
500–600
400–500
300–400
200–300
100–200
BAY OF BENGAL
ARABIAN SEA
INDIAN OCEAN
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)

Fig- 5.15

the Primary Health Care System. It was presumed that urban malaria cases will be adequately dealt with by the private practitioners and network of hospitals and dispensaries located in urban areas. This could not happen as the population from slum areas seldom visited the hospitals or dispensaries due to inadequate finances to consult the private medical practitioners.

i. Transmission Dynamics in Urban Areas

In urban areas in the built-in portion of the township, *An.stephensi* is the principal vector. The type form of *An.stephensi* is predominantly urban, while *mysorensis* is mostly found in rural areas. The type form of *An.stephensi* has been recorded from major cities like Delhi, Mysore, Bangalore, etc. while both type form and *mysorensis* have been encountered in Pune, Calcutta, etc. The distribution of type form or *mysorensis* requires precise mapping. *An.stephensi* breeds predominantly in man-made water collections, places like wells, overhead tanks, ornamental tanks, cisterns, roof gutters, water storage containers, construction sites, room coolers, leaking water meters, boxes, valve chambers, etc. During construction of houses, for curing concrete floors and roofs, the area is covered with water and such places are notorious for prolific breeding of *An.stephensi*.

From the above it is evident that *An.stephensi* breeds in the domestic and peri-domestic water collections in man-made containers. It is normally very difficult to find adequate number of *An.stephensi* from indoor collections. It has been observed that usually *An.stephensi* rests in wells and water tanks where the breeding takes place. It goes out to have blood meal but returns to the resting place as soon as possible. The biting time starts soon after dusk. The peak biting is observed between 4 a.m. and 6 a.m. Therefore, it is evident that there will be little impact on transmission by *An.stephensi* if residual insecticide spray is carried out. The vector has shown resistance to most commonly used insecticides in public health. The man-mosquito contact usually takes place indoors during early hours of the morning - 4 a.m. to 6 a.m. It is an indiscriminate feeder. Therefore, higher densities similar to those of *An.culicifacies* are required for malaria transmission. The completion of extrinsic cycle of malaria parasite in *An.stephensi* is readily affected by temperature and humidity variations. At 10^0 C temperature with varying degrees of relative humidity from 50 to 100 per cent, no infection was recorded in the vector. On the other hand, extreme temperature of 37.8^0 C (100^0 F) was not found favourable as no vector survived long enough to become infective. *P.vivax* infection was recorded from 15.6^0 C (60^0 F) to 32.2^0 C (90^0 F). The heaviest sporozoites infection was obtained at 26.7^0 C (80^0 F).

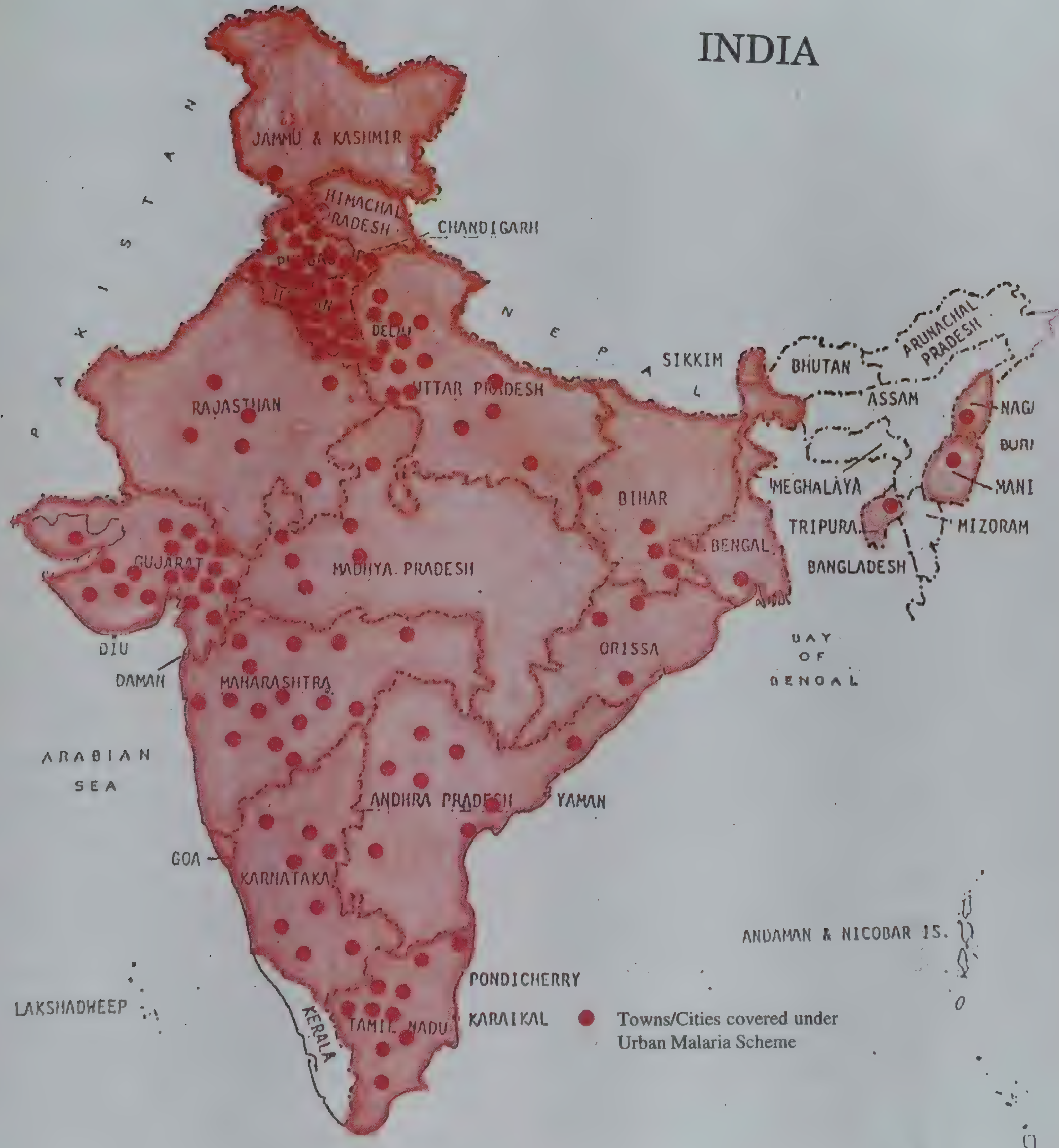
The completion of *P.vivax* sporogony was recorded in 18 days at 15.6^0 C (60^0 F), 16 days at 21.1^0 C (70^0 F), 11 days at 26.7^0 C (80^0 F) and 9 days at 32.2^0 C (90^0 F). The completion of *P.falciparum* sporogony was 14 days at 21.1^0 C (70^0 F), 10 days at 26.7^0 C (80^0 F) and 9 days at 32.2^0 C (90^0 F). Thus *P.falciparum* takes one or two days more for completion of sporogony in *An.stephensi* as compared to *P.vivax*.

The recent studies by Malaria Research Centre show that under controlled laboratory conditions, at same temperature levels, the extrinsic cycle in *An.stephensi* has shown difference in Delhi and Madras. In Delhi the extrinsic cycle takes 8 days for completion, while in Madras it takes 11 to 12 days. Therefore transmission dynamics in Northern India and Southern India will be affected by this characteristic aspect of *An.stephensi* besides temperature. The vector maintains moderate endemicity in built-in urban areas, but it is responsible for causing fulminating epidemics in certain cities. The epidemic in Bombay was precipitated by opening up of closed wells for fire fighting purposes during II World War and thereafter it was controlled by hermetically sealing these wells.

The distribution of urban vector in malaria endemic towns is shown in Fig- 5.16.

ii. Transmission Dynamics in Peri-Urban Areas

In Peri-urban or in urban pockets where agriculture land is located, the transmission by *An.stephensi* is supported by *An.culicifacies*. The sibling species of *An.culicifacies* responsible for malaria transmission in peri-urban situation will be governed by the distribution of sibling species



Reported distribution of *An.stephensi* in India

Fig- 5.16

in the country especially in the particular area. The details regarding transmission dynamics in areas under the influence of *An.culicifacies* are given in plain areas. In peri-urban areas, both vectors supplement each other and transmission in peri-urban areas is of a higher magnitude than those in the built in areas. The situation is worse in urban slums located at the periphery of the city/town. Both *An.stephensi* and *An.culicifacies* have shown resistance to DDT and HCH. However, larvae of *An.stephensi* as well as *An.culicifacies* are amenable to larvicides in use. In permanent water collections, the use of larvivorous fish should be preferred as an antilarval measure. In this paradigm, it is essential to establish early case detection and treatment mechanism through ACD and PCD for identification of worst affected sections of the urban community.

The intervention measures for transmission control in urban areas are based on antilarval operations. It is easier to implement these operations in urban areas because most of the breeding habitats of *An.stephensi* are man made and of permanent nature which can be easily enumerated and brought under antilarval operations. In the peri-urban area, *An.culicifacies* prefers to breed in surface water collections which are temporary, thus escaping antilarval measures. Therefore, in peri-urban areas, the intervention measures or antilarval measures should be supported with residual insecticidal spray or bednets whichever is preferred/accepted by the community.

iii. Intervention Measures

The intervention measures recommended in urban areas are given in detail in Chapter-6 and the salient points are given below :-

i. Recurrent antilarval measures at weekly interval with recommended larvicides such as MLO, temephos, fenthion, biocides, etc.

ii. Use of bio-environmental control measures such as larvicides fish, EPS beads, etc.

iii. Water management by providing appropriate water supply and disposal.

iv. Improvement of storm water drainage.

v. Source reduction of peri-domestic water bodies by drainage and filling in urban and peri-urban areas.

vi. Indoor space spraying with pyrethrum in and around 50 houses where malaria positive case is detected.

vii. Enactment and strict implementation of civic by-laws in Municipalities and Corporations to reduce/eliminate domestic and peri-domestic breeding places.

viii. Spraying of indoor residual insecticide in slums and peri-urban areas where antilarval measures are either not feasible or do not make a good impact on the transmission.

The Expert Committee on Malaria (1995) identified 15 cities/towns as high risk urban areas and 14 towns where more than 10% SPR was recorded during 1991-93.

The total population in all the 29 towns and cities is about 45 millions where accelerated malaria control measures were recommended by the Expert Committee.

The disease control measures recommended by the Committee are as follows:-

a. Fortnightly domiciliary visits in the slum areas by establishing organisation for active case detection @ one worker per 20,000 population.

b. Strengthening of passive case detection mechanism in hospitals and dispensaries by providing a worker for collection of blood smears from fever cases in O.P.D. @ one worker per 200 patients attending O.P.D. per day.

c. Presumptive treatment to all fever cases from whom blood smears are collected.

d. Expeditious examination of blood smears collected in the active and passive case detection by opening one malaria clinic for every 50,000 population or part thereof manned by a trained laboratory technician in malaria microscopy so that the radical treatment is administered to all the positive cases at the earliest, preferably within 48 hours of blood smear collection.

PROJECT AREAS - LOCATED IN DIFFERENT MALARIA PARADIGMS

One of the malaria paradigms classified by the Expert Committee on Malaria - 1995 is project malaria.

Since independence, India has set up a large number of projects for development of country's economy. India has made rapid progress during successive Five Year Plans in achieving self-sufficiency in agricultural products and has also distinguished itself in industrial production. India has largest area under agriculture in the world. Foodgrain production has increased from 54.9 million tons in 1949-50 to 180 million tons in 1992-93. Although there has been marked deforestation in the country for opening up new areas for agriculture purposes, still the country has 75.23 million hectares of forests. There are large number of developmental activities connected with forest products. Net area under agriculture has increased from 119 million hectares to 142 million hectares in 1992-93. Self-sufficiency in agricultural sector was possible by increasing irrigation potential through setting up water resources development projects like major, medium and minor dams. The irrigation potential has increased from 22.6 million hectares to 83.5 million hectares over the last four decades.

Industrialisation has been progressing rapidly in the country. During the last 48 years, public sector played a prominent role in establishing basic industries - steel, non-ferrous metals, petroleum, coal, fertilisers and heavy engineering. Country has made big strides in consumer oriented industries like textiles, drugs, pharmaceuticals, cement, sugar, etc. The number of public sector enterprises which were only 5 in March, 1951 rose to nearly 244 in March, 1991. With the advent of new industrial policy, the private sector is also making rapid progress and is establishing units for production of consumer goods and export oriented products. To achieve these, it became necessary to develop extensive infrastructure in power, communication and transport sectors.

The industrial development and mineral wealth in India are shown in Fig-5.17 and Fig- 5.18 respectively.

Location of Developmental Project and its Influence on Transmission Dynamics

The transmission dynamics differ widely from one project to another. The difference in malaria transmission dynamics is sometimes more pronounced due to location of the project. There will be difference in transmission dynamics of a project located in plains or forest or a river valley project in hilly areas.

Some of the Common Features in Developmental Projects Related to Transmission Dynamics

There are a large number of common features in developmental projects which are conducive for high malaria incidence during the construction stage of the project and sometimes thereafter.

A large number of industrial developmental projects are located in the proximity of highly malarious forested areas because of the easy availability of raw materials like metals, coal and forest products in the vicinity. The location of an industrial unit near the source of raw materials facilitates easy and quick transportation thereby reducing the total cost of the product.

Some State Governments as well as Central Government do provide monetary incentive to private sector for locating the industry in backward districts with an idea to achieve socioeconomic progress in these areas. Such areas are usually highly receptive and vulnerable to malaria.

At the initial stage during construction at the project site, there is tropical aggregation of labour from areas of different malaria endemicity. They bring different strains of malaria parasite to the project site including drug resistant strains.

Industries are often set up in areas not fit for agriculture use. Due to cheap availability of land in the vicinity of project sites, new settlements come up and in the absence of proper land development in siting of township, these settlements usually have very high mosquitogenic potential.

The majority of industries require huge quantities of water for industrial purposes. Therefore, they are normally located near a water source in riverine belt areas where adequate water is available to meet their needs. The industries do not implement adequate water management system resulting into aggregation of numerous breeding places for malaria vector.

Many river valley townships are constructed very near the reservoir or perennial seepage canals providing large number of places for vector breeding favouring frequent man-mosquito contact. The near absence of cattle in the developmental

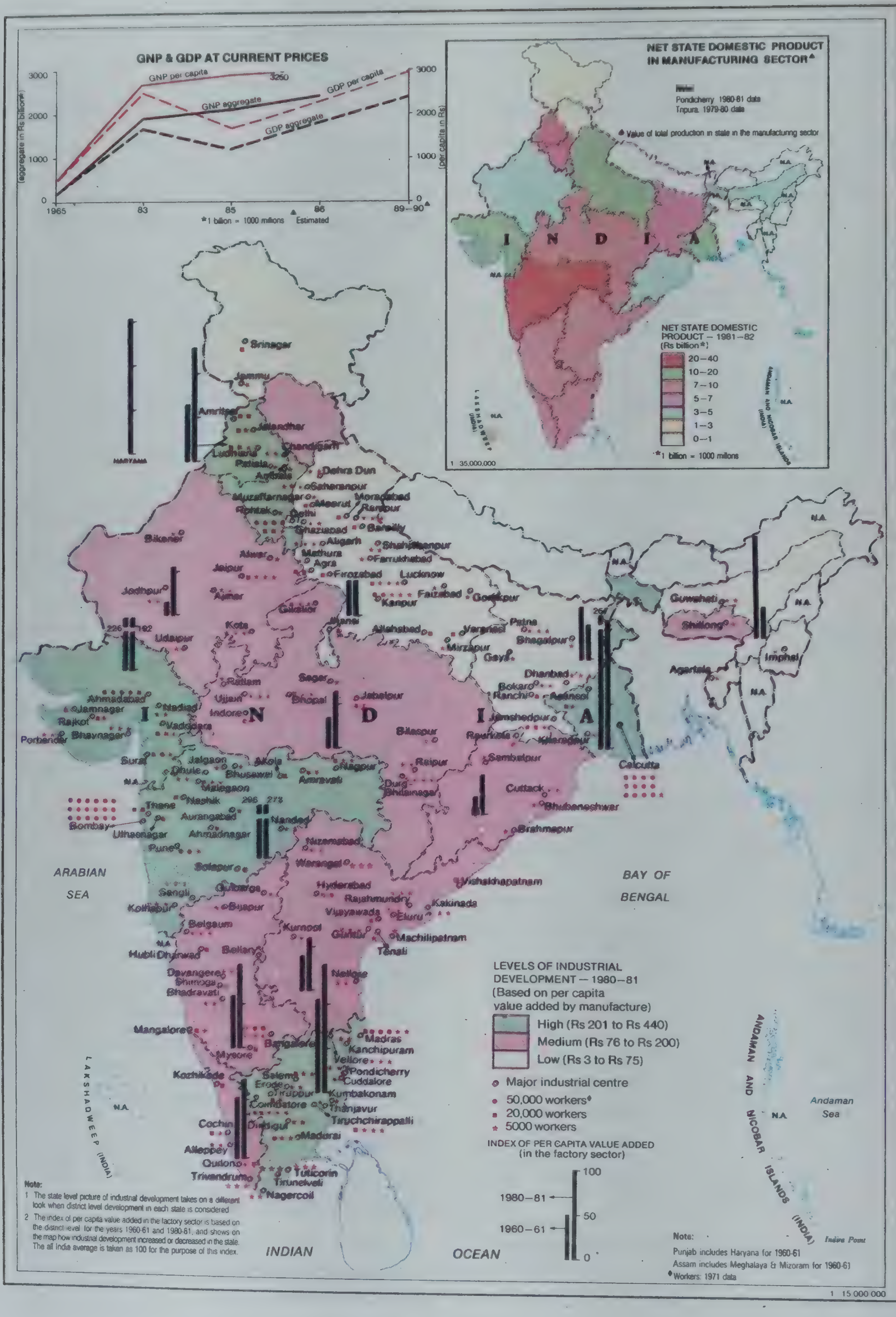
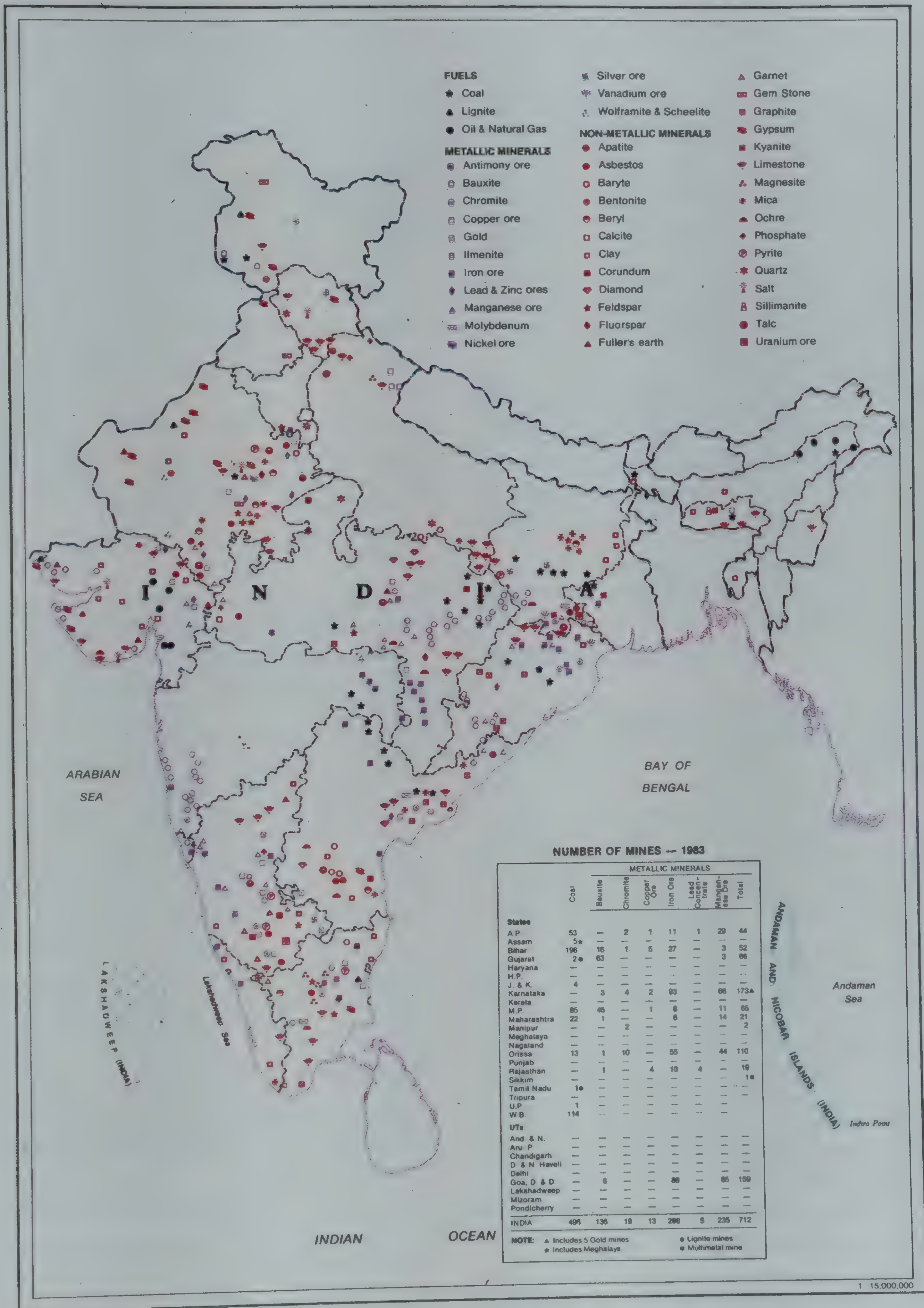

GNP & GDP AT CURRENT PRICES
GNP per capita
GNP aggregate
GDP per capita
GDP aggregate
(aggregate in Rs billion*)
(per capita in Rs)
*1 billion = 1000 millions
Estimated
NET STATE DOMESTIC PRODUCT IN MANUFACTURING SECTOR▲
Pondicherry 1980-81 data
Tripura 1979-80 data
▲ Value of total production in state in the manufacturing sector
NET STATE DOMESTIC PRODUCT – 1981–82 (Rs billion*)
20–40
10–20
7–10
5–7
3–5
1–3
0–1
*1 billion = 1000 millions
INDIA
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
Andaman Sea
ANDAMAN AND NICOBAR ISLANDS (INDIA)
LAKSHADWEEP (INDIA)
LEVELS OF INDUSTRIAL DEVELOPMENT — 1980—81
(Based on per capita value added by manufacture)
High (Rs 201 to Rs 440)
Medium (Rs 76 to Rs 200)
Low (Rs 3 to Rs 75)
Major industrial centre
50,000 workers♦
20,000 workers
5000 workers
INDEX OF PER CAPITA VALUE ADDED (in the factory sector)
1980–81
1960–61
Note:
1 The state level picture of industrial development takes on a different look when district level development in each state is considered
2 The index of per capita value added in the factory sector is based on the district level for the years 1960-61 and 1980-81, and shows on the map how industrial development increased or decreased in the state. The all India average is taken as 100 for the purpose of this index.
Note:
Punjab includes Haryana for 1960-61
Assam includes Meghalaya & Mizoram for 1960-61
♦Workers: 1971 data
1 : 15 000 000
Srinagar
Jammu
Amritsar
Jalandhar
Chandigarh
Ludhiana
Patiala
Ambala
Dehra Dun
Saharanpur
Muzaffarnagar
Meerut
Moradabad
Rampur
Rohtak
Delhi
Ghaziabad
Bareilly
Aligarh
Shahjahanpur
Mathura
Agra
Farrukhabad
Bikaner
Alwar
Jaipur
Firozabad
Lucknow
Jodhpur
Ajmer
Kanpur
Faizabad
Gorakhpur
Gwalior
Kota
Jhansi
Allahabad
Varanasi
Patna
Udaipur
Mirzapur
Bhagalpur
Gaya
Guwahati
Shillong
Imphal
Agartala
Ratlam
Sagar
Dhanbad
Bokaro
Ranchi
Asansol
Ahmadabad
Nadiad
Ujjain
Bhopal
Jabalpur
Jamnagar
Indore
Rajkot
Vadodara
Jamshedpur
Kharagpur
Porbandar
Bhavnagar
Bilaspur
Rourkela
Calcutta
Surat
Jalgaon
Akola
Nagpur
Raipur
Sambalpur
Dhule
Bhusawal
Amravati
Durg
Bhilainagar
Malegaon
Cuttack
Thane
Nashik
Bhubaneshwar
Bombay
Aurangabad
Nanded
Brahmapur
Ulhasnagar
Ahmadnagar
Pune
Nizamabad
Solapur
Warangal
Hyderabad
Vishakhapatnam
Sangli
Gulbarga
Rajahmundry
Kolhapur
Bijapur
Vijayawada
Kakinada
Eluru
Belgaum
Kurnool
Guntur
Machilipatnam
Hubli Dharwad
Bellary
Tenali
Davangere
Shimoga
Bhadravati
Nellore
Mangalore
Madras
Kanchipuram
Mysore
Bangalore
Vellore
Pondicherry
Kozhikode
Salem
Cuddalore
Erode
Tiruppur
Kumbakonam
Coimbatore
Thanjavur
Tiruchchirappalli
Cochin
Dindigul
Madurai
Alleppey
Quilon
Trivandrum
Tuticorin
Tirunelveli
Nagercoil
Indira Point
N.A.

Fig- 5.17



NUMBER OF MINES — 1983

	Coal	METALLIC MINERALS: Bauxite	Chromite	Copper Ore	Iron Ore	Lead Concen-trate	Mangan-ese Ore	Total
States								
A.P.	53	—	2	1	11	1	29	44
Assam	5★	—	—	—	—	—	—	—
Bihar	196	16	1	5	27	—	3	52
Gujarat	2●	63	—	—	—	—	3	66
Haryana	—	—	—	—	—	—	—	—
H.P.	—	—	—	—	—	—	—	—
J. & K.	4	—	—	—	—	—	—	—
Karnataka	—	3	4	2	93	—	66	173▲
Kerala	—	—	—	—	—	—	—	—
M.P.	85	46	—	1	8	—	11	66
Maharashtra	22	1	—	—	6	—	14	21
Manipur	—	—	2	—	—	—	—	2
Meghalaya	—	—	—	—	—	—	—	—
Nagaland	—	—	—	—	—	—	—	—
Orissa	13	1	10	—	55	—	44	110
Punjab	—	—	—	—	—	—	—	—
Rajasthan	—	1	—	4	10	4	—	19
Sikkim	—	—	—	—	—	—	—	1■
Tamil Nadu	1●	—	—	—	—	—	—	—
Tripura	—	—	—	—	—	—	—	—
U.P.	1	—	—	—	—	—	—	
W.B.	114	—	—	—	—	—	—	
UTs								
And. & N.	—	—	—	—	—	—	—	—
Aru. P.	—	—	—	—	—	—	—	—
Chandigarh	—	—	—	—	—	—	—	—
D. & N. Haveli	—	—	—	—	—	—	—	—
Delhi	—	—	—	—	—	—	—	—
Goa, D. & D.	—	6	—	—	88	—	65	159
Lakshadweep	—	—	—	—	—	—	—	—
Mizoram	—	—	—	—	—	—	—	—
Pondicherry	—	—	—	—	—	—	—	—
INDIA	496	136	19	13	298	5	235	712

NOTE: ▲ Includes 5 Gold mines ● Lignite mines
★ Includes Meghalaya ■ Multimetal mine

Fig- 5.18

project area is also one of the factors modifying the transmission dynamics in the project area.

In the project area, absence of cattle diverts *An.culicifacies*, a pronounced zoophilic mosquito, to human population and even in low densities, it transmits malaria.

During the construction stage of industrial areas and river valley projects, numerous breeding places are created by indiscriminate digging of soil for construction work where during rainy season, water stagnation occurs providing vector breeding habitat. The labour camps located near such diggings are often exposed to severe malaria transmission. Lastly the developmental projects usually do not incorporate health safeguards in the project document. In the absence of linkages between health and industry, the site selection, measures for prevention of disease transmission in the area are done arbitrarily which are mostly non-effective. The project authorities invest huge funds on providing facilities for curative purposes by establishing hospitals, etc. On the other hand they do not provide adequate infrastructure to take up disease control programme.

Examples of Malaria Transmission in Developmental Projects and Some Special Characteristics

There are innumerable examples of the developmental projects recording high incidence of malaria. For example Mirzapur Thermal Power Project was mainly responsible for increasing *P.falciparum* incidence from 2421 cases in 1979 to 11,455 cases in the following year due to construction activity in the project area. Similarly Visakhapatnam Steel Plant in Andhra Pradesh contributed 40 to 72% of the total malaria cases in the district during the construction phase between 1987 and 1990. In Upper Krishna Irrigation Project areas (Karnataka), the API shot up from 37 in 1983 to 146 in 1987 during construction of the project. Similar examples are discernible in Mathura Refinery Complex, Narmada Valley Developmental Project, National Thermal Power Corporation in Dadri (Uttar Pradesh), etc.

Malaria in developmental projects is not a recent phenomenon. Senior White and Das quoted the devastating damage caused by malaria in Singhbhum hills way back in 1920s. Sinton reported that malaria was a great obstacle in many localities for the development of mineral wealth in India and he also mentioned that the furnaces at the smelters were almost brought to a standstill on an occasion in Orissa because no less than seven trains which had gone for ore, had been abandoned at the mines by the drivers, firemen, guards and other railway staff at the station as they were down with malaria. The problem of malaria is often rampant in seasonal working camps in forests for bamboo cutting, charcoal making, fuel wood collection, logging, etc.

The usual peculiarity of forest labour within the district is that when they fall sick with malaria in forest camps, they migrate back to their native places for treatment and recoupment. In this process they set-up local transmission in the areas of their permanent residence.

Vectorial Aspects

Different malaria vectors transmit the infection in developmental projects depending upon the location of project in the given malaria paradigm. In developmental projects located in the midst of forest in North-Eastern States, *An.dirus* freely transmits malaria in the outdoors without any chance of exposure to residual insecticidal spray. Similarly *An.minimus* acts as a very efficient vector in the projects located at the margins of foothills. *An.fluviatilis* adopts to a wide distribution range and forms a serious combination with *An.culicifacies*. These two vectors complement each other without inter-specific competition in space and time since the breeding places and peak density periods differ and thus prolonging the transmission period favouring higher incidence of *P.falciparum* infection.

Malaria Control Strategy

The following broad guidelines should be followed in the developmental projects for the control of malaria.

i. Wherever a developmental project employs a substantial labour force, it should set-up a separate organisation for malaria control. The population to be protected from malaria should not only include the labourers in the project but also their family members and the local community living in the vicinity of the project.

ii. In case the labour population is small, the existing health infrastructure under the Primary Health Care System should undertake all measures for control of malaria supplemented with the additional funds provided by the project.

iii. The project authorities should have close liaison with malaria department at planning, construction and maintenance phases so that malaria should not pose a problem. The implementation of many projects was unduly delayed in the past because of malaria.

iv. Environmental engineering methods for malaria control should be incorporated at planning and design stage.

v. The health survey including malaria and mosquitogenic potential should be carried out by project authorities through a multidisciplinary team in collaboration with State Health Organisation and other concerned departments at the planning stage.

vi. After initial assessment survey on malaria and mosquitogenic potential, the labour camps should be located in healthy sites away from the flight range of the vector. The project township and offices should be located beyond the flight range of the vector which breed in the impounded water of the reservoir and distributary system.

vii. Proper management of water supply and water disposal should be incorporated in offices and residential areas. The roof structure and design of the building should be mosquito proofed so as to prevent intra-domestic and peri-domestic mosquito breeding.

viii. Special clauses should be incorporated in the contracts and subcontracts so that the earth work for construction purposes does not leave behind mosquito breeding places. All the pits created by mining projects, stone quarries, road and rail construction, etc. should be filled in a proper gradient to prevent stagnation of water. The earth for construction should be brought from higher elevations without causing depressions.

ix. The construction of roads, rails, bridges, etc. should not form obstacles for natural flow of drain water.

x. The developmental projects should earmark adequate proportion of budget for undertaking malaria control measures at planning, design, construction and maintenance phases.

xi. Wherever water storage becomes necessary it should be disposed of within seven days. Where it is not possible to dispose the water within seven days, the water bodies should be subjected to larviciding either by bio-environmental manipulation methods or chemical control.

xii. Residual insecticidal spray should be given in the temporary hutments of migratory labour with required number of spray rounds.

xiii. All new hutments as and when built up should be immediately sprayed with insecticide irrespective of transmission season.

xiv. The composition of malaria control unit should be as per the guidelines given in Operational Manual on Malaria Action Programme - 1995.

xv. There should be highest degree of intersectoral coordination among implementing agencies for prevention and control of malaria.

Disease Management

i. Itinerant incoming and outgoing labourers should be mass screened and administered presumptive treatment with Chloroquine along with Primaquine at the recommended doses.

ii. The active case detection should be at weekly interval and the blood smears collected should be examined within 48 hours to enable prompt administration of radical treatment to all malaria positive cases.

iii. Adequate number of FTDs and Voluntary Link Workers should be established from among the literate labour community residing in the locality with intensified IEC to inhabitants for observing personal prophylactic measures.

iv. Malaria clinics with trained laboratory technicians should be established so that each clinic will be able to process and examine a minimum of 50 blood smears per working day.

v. Good referral linkage should be developed for proper and prompt management of severe and complicated malaria as given in Operational Manual of Malaria Action Programme - 1995.

Rain Forests of Western Sub-Himalayan Region - Vector *An.fluviatilis* and *An. culicifacies*

The North-Western Himalayan belt comprises of Jammu & Kashmir, Himachal Pradesh, Northern border of Punjab and Haryana, Garhwal & Kumaon region of Uttar Pradesh. The hills and foothills of these areas are studded with rain forests. The weather is generally cool in summers and very cold in winters. The transmission of malaria is interrupted when the ambient temperature falls below 16^0 C usually between October and February each year. There are forest streams which are perennial. The relative humidity is high but not sufficiently high for survival of *An.dirus*. Malaria transmission in the area is prolonged.

The Sub-Himalayan region is characterised by two distinct landscapes. Immediately abetting the foothills is a porous soil belt which is 10 to 16 kms wide with rocky formation, the ground slopes at the rate of nearly 13 to 15 metres per km. This area is usually dry. During monsoon, the streams overflow and vast areas are inundated for short period of time. Southwards of Bhabar is a wet belt of loamy clay soil. The area has extensive grassland. The forest is comparatively less dense than the forest in Bhabar or hilly areas. There are hardly any rocky formations. The landscape is comparatively less steep than Bhabar. Usually the gradient is 1.5 to 2 metres per km. There is high sub-soil water level almost reaching the ground surface creating large swamps and very slow running streams. The environment is very conducive for mosquito breeding. Drop in temperature during winter months is much less as compared to hilly or foothill areas of Himalayan belt. The transmission dynamics of malaria have been extensively studied in this area. In the past during construction phase of Sharda Canal between 1920 and 1929, a very well-documented report on malaria transmission dynamics and effective control operations was published. A similar project in Banbasa near Indo-Nepal Border was executed between 1927 and 1929. This again highlighted the malariogenic potential of the area.

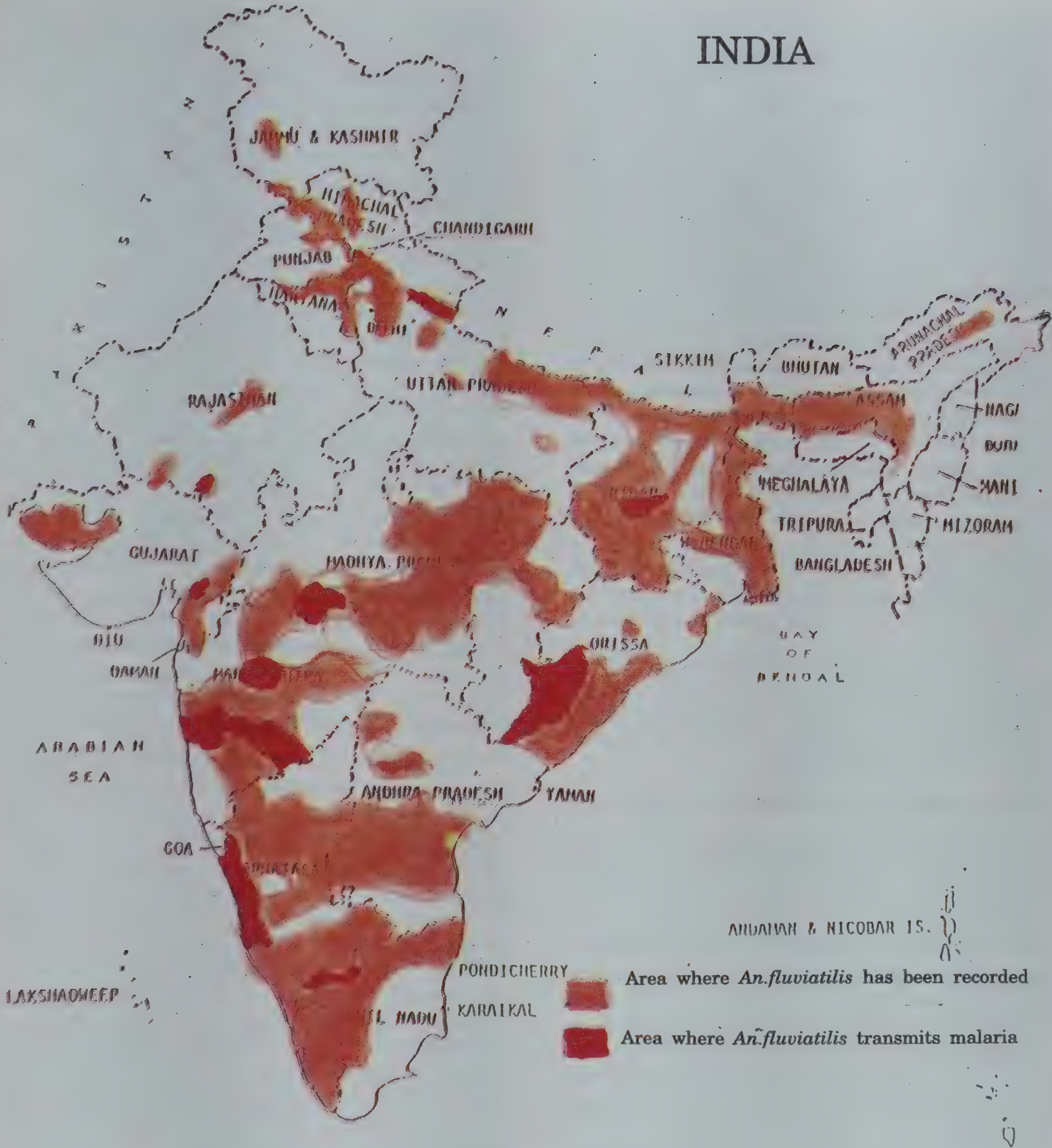
Transmission Dynamics of Forest Valley and Foothill Forests

In these areas the malaria transmission is maintained by *An. fluviatilis*. It has the same bionomics as observed in Deccan Plateau and North-Eastern States of India. It breeds in well-lit slow moving streams and is highly anthropophilic and endophagic. Its area of influence is in the forest valley and foothill areas. In agriculture areas along forest fringes, *An.culicifacies* supports malaria transmission during monsoon season, while *An.fluviatilis* plays a major role in transmission of malaria during late monsoon. Therefore, the incidence of malaria in the foothill forest fringe is much higher than the malaria incidence in the deep forest areas.

The distribution of *An.fluviatilis* in India is shown in Fig-5.19

A lot has been written about agro-ecosystem of Sub-Himalayan region. The recent observations and publications of Malaria Research Centre indicate that *An.culicifacies* breeds in rice fields during early period of rice crops when the plant is not more than 18" (45 cms) high. Thereafter there is succession of other Anopheline and Culicine mosquitoes in the rice agro-systems. All these mosquitoes are not vectors of malaria. It can be concluded that only for a very short period of time i.e. 15 to 30 days, the rice fields provide breeding ground for *An.culicifacies*. The bulk of the transmission is supported by breeding of *An.culicifacies* in surface water collections outside the rice fields during monsoon. The transmission by *An.culicifacies* is later on super-imposed by influence of *An.fluviatilis* breeding in irrigation channels of agriculture fields. The peak density of *An.fluviatilis* is obtained during the later part of the monsoon when slow moving streams carry clear water. Some research workers are of the opinion that *An.fluviatilis* is a complex of two biological races (i) prevalent in hills and foothills all over the country and (ii) in plains of Deccan Plateau. The foothill variety of *An.fluviatilis* is exophagic/endophagic and anthropophilic.

The paradigm in Bhabar and Terai areas away from the forest fringes (2 km) is marked by the vectorial influence of *An.fluviatilis* and *An.culicifacies*. The habits of *An.fluviatilis* have been described in the paradigms connected with peninsular India and North-Eastern Sub-Himalayan ranges. In the Western Himalyan Ranges the malaria transmission by *An.fluviatilis* is usually terminated due to fall in temperature with onset



Reported distribution of *An.fluviatilis* in India

Fig- 5.19

of winter. In this part, vector *An.culicifacies* also supports the transmission of malaria during early rainy period. In this area sibling species 'A' of *An.culicifacies* is prevalent which is a very efficient vector of malaria. However, *An.culicifacies* is an opportunistic biter. It feeds indiscriminately on man and animal. Therefore, man animal ratio in the locality will alter the transmission dynamics of malaria where *An.culicifacies* is a primary vector. This vector has shown resistance to all conventional insecticides because of their extensive use in agriculture and malaria control operations. In these areas, it is difficult to control malaria because the transmission season is prolonged under the influence of two vectors and both vectors have distinct bionomic characteristics. The preferred method of malaria control in these areas will be indoor residual insecticidal spray with alternative insecticide to which the vector is susceptible. Selective vector control and water management should form the main thrust for malaria control. The impregnated bednets will not give desired impact on malaria transmission because of early biting time of both the vectors.

Having dealt with malaria paradigms in North-Eastern, Peninsular India and Sub-Himalayan region, it now remains to discuss malaria paradigms of Indo-Gangetic plains and coastal areas of Peninsular India.

RURAL MALARIA IN INDIAN PLAINS

The last paradigm which requires a detailed discussion comprises of Indo-Gangetic plains, plains of Brahmaputra Valley and plains of Deccan Plateau. Looking at old endemicity map of India pertaining to the year 1948 (vide Fig- 1.1 on page no.5.), this region was described as region of variable endemicity. It is also mentioned in literature that in these areas, *An.culicifacies* is the main vector. The variability of the malaria endemicity in these plain areas associated with vectorial influence of *An.culicifacies* was explained by a variety of reasons ranging from fluctuations in rainfall to ranges of temperature and humidity. It was very difficult to estimate endemicity levels in these areas in a continuum. There were wide fluctuations in malaria incidence from year to year. Recent studies in cytogenetics of malaria vectors have established that the vector *An.culicifacies* is not a single species but is complex of four sibling species. Looking at the distribution of sibling species, it is observed that all four sibling species are found in foothill and plain areas surround by Aravalli, Satpura and Vindya ranges and eastern slopes of Western Ghats. This seems to be the epicentre of *An.culicifacies* origin in the Indian sub-continent. It is also postulated that the sibling species now known as 'B' of *An.culicifacies* appears to be the parent strain of *An.culicifacies*, which could have undergone differentiation into other sibling species probably due to ecological factors. There is a strong collaboration between the soil characteristics of the area and distribution of sibling species. All four sibling species except B are associated with mountain soil which is prevalent in the coastal areas of Eastern Ghats and Western Ghats as well as in the Gangetic and Brahmaputra plains north of Ganges, while sibling species C & B are associated with red sandy soil and in this situation sibling species C predominates. Similarly in red loamy soil on the slopes of Western Ghats, part of plains of Orissa and plains of Tamil Nadu, B & C are found in association with litterite soil. Predominance of A sibling species is found in a variety of soil structures on north-western direction from the epicentre of *An.culicifacies*. It has been observed that most often sibling species D is found in association with sibling species A.

The studies on vectorial capacity of different sibling species have revealed that sibling species B is not a vector of malaria and this commensurates with the fact that in eastern Uttar Pradesh and Bihar north of Ganges and plains between Ganges and Brahmaputra, no malaria transmission takes place because only sibling species B is present in this region. However a variant of B is found in the southern plains of India near Rameswaram Island which is an efficient vector of malaria. It is more akin to *An.culicifacies* found in Sri Lanka and is associated with distribution of alluvial soil, same as the sibling species B in the north/north-eastern plains. Out of the four sibling species, A, D & C are vectors of malaria. The vectorial capacity of these three sibling species is still under study. However, A and D sibling species seem to possess higher vectorial capacity than C sibling species. Therefore, the area comprising of Indo-Gangetic and Brahmaputra plains along with peninsular plains can be divided into four different paradigms of malaria, which are:-

i. Gangetic and Brahmaputra plains, **North of Ganges** characterised by alluvial soil from 82^0 to 96^0 East longitude. This region is a hypo-endemic area with no indigenous transmission of malaria.

ii. These paradigms are associated with distribution of *An.culicifacies* sibling species A & B in plains of Haryana, Punjab and Western districts of Uttar Pradesh. In this area, at present malaria is meso-endemic. The changes are probably due to intensive canal irrigation in the area. It can be presumed that *An.culicifacies* sibling species A prefers breeding habitats associated with canal irrigation system because it has been observed that ground collections of rain water is the preferred breeding habitat of *An.culicifacies* sibling species B. During the rainy season in all areas, proportion of B shows a rise in relation to the densities of other sibling species of *An.culicifacies*. Therefore, it is safe to suggest that *An.culicifacies* sibling species A may prefer breeding habitats created by canal irrigation.

iii. In the eastern coastal plains mostly sibling species B & C are encountered. In areas where B alone is found, the malaria transmission does not take place while C is a good vector of malaria and focal transmission takes place in some of the coastal areas. Same can be said about transmission in coastal plains of the Western Ghat south of Goa.

As one goes up along the coast, all three species A, B & C are found in the coastal plains of Gujarat and Rann of Kachchh. A & C being good vectors of malaria, meso-endemic conditions of transmission of malaria are produced in this region.

iv. The fourth paradigm of malaria is the peninsular plains surrounded by Eastern and Western Ghats, Satpura and Vindya ranges in the north. In this area, all sibling species of *An.culicifacies* (A, B, C & D) are present but the distribution is patchy. There are areas where only B & C or A & C are present. That is why the incidence of malaria varies from place to place in this area.

Control Strategy

For planning malaria control operations on some realistic basis, it may be essential to identify sibling species distribution of *An.culicifacies* in the area and accordingly the transmission control measures can be planned. In areas, where only sibling species B is present, no intervention measures for transmission control are necessary. But in areas where other siblings are also present, transmission control measures have to be selected very carefully. It has been found that compared to sibling species A, sibling species C & D developed resistance to insecticides very quickly. Therefore, in areas where malaria transmission is characterised by predominant influence of sibling species A, insecticidal spray operations will be more effective and for a longer period of time, but in areas where sibling species C & D are primary vectors of malaria transmission, the insecticide should be carefully chosen and used for malaria control very judiciously because these vectors are likely to develop resistance to insecticide more quickly. All the sibling species are predominantly zoophilic. They feed on cattle populations and less on human population. Among sibling species, A is more anthropophilic as compared to other sibling species. The biting of *An.culicifacies* starts at dusk but peaks between 9.30 p.m. and 11.30 p.m. Depending on the degree of transmission control required, the mode of application of insecticide can be selected. An indoor residual insecticide spray will give a better control of transmission. However, partial control of transmission can be obtained by use of impregnated bednets.

Bio-environmental control of malaria transmission becomes difficult in rural areas with extensive agriculture and with large temporary and permanent number of breeding places of *An.culicifacies* throughout the long rainy season. Due to existence of large number of larval habitats of *An.culicifacies,* it is not possible to implement bio-environmental control measures through the existing organisation available with the primary health care system.

The distribution of malaria vectors in India is shown in Fig- 5.20.

The salient bionomics of principal malaria vectors in India are given in Annexure- 5.1.

IMPACT OF CHEMOTHERAPEUTIC MEASURES ON TRANSMISSION DYNAMICS

Generally, when chemotherapeutic measures are discussed in the context of malaria control operations, the entire emphasis is laid down on early case detection and prompt treatment of a malaria patient for complete clinical and parasitological cure. **However, another aspect which is usually not discussed is the impact of antimalarial chemotherapeutic measures on transmission dynamics of malaria.**

The general practice is to administer a schizonticidal drug with supportive treatment for early clinical management and parasitological cure of malaria cases. To achieve this, most of the programmes especially the Indian Programme resort to administration of presumptive treatment with a schizonticidal drug, usually Chloroquine. It is given to all fever cases who are presumed to be suffering from malaria. Apart from strong schizonticidal action, Chloroquine **has effect on gametocytes of *P.vivax* and developing gametocytes of *P.falciparum*. It has no effect on mature gametocytes of *P.falciparum*.**

Normally malaria presents with fever. In the early stages, usually fever does not show typical intermittent periodicity with well marked cold stage and fever free period. Sometimes in the beginning of the episode the fever is not very high. **The general tendency is to wait and watch for sometime before seeking specific antimalarial treatment for fever.** Patient usually resorts to the use of antipyretics and waits to see whether the fever continues and other accompanying sign and symptoms ameliorate or increase in intensity before seeking antimalarial treatment. This is applicable to all rural and urban situations. Usually a malaria patient reports after a delay of a few days even to a voluntary post in the locality (FTD/DDC). During this period, in both *P.vivax* and *P.falciparum* infections some gametocytes appear in the circulation although the count may not be high and sometimes it may be below the levels where gametocytes can be readily detected by microscopy.

Presumptive treatment with 600 mg or 1500 mg of Chloroquine schedule followed in a country achieves parasitic remission of schizogonic stages both in cases of *P.vivax* and susceptible strains of *P.falciparum*. In *P.vivax* the gametocytes are also affected by Chloroquine. However, gametocytes of *P.falciparum* continue to circulate in peripheral blood and are infective to the mosquito. The radical treatment usually with Primaquine, a gametocytocidal drug, is given only after microscopic confirmation of the case. There is always a delay in administration of Primaquine which sometimes extends from 48 hours (in case of a PHC or other agencies where facilities for microscopic examination of blood smears exist) to as long as 30 to 40 days between administration of presumptive treatment, collection of blood smear, its examination and administration of radical treatment to a positive case. More than 90% of cases in this country are given radical treatment after a lapse of 15 to 20 days. During this period because of the effect of Chloroquine on the gametocytes of *P.vivax*, transmission of *P.vivax* is prevented, but *P.falciparum* case continues to have circulating gametocytes and in case the intervention measures are not adequate to interrupt local transmission, *P.falciparum* cases will continue to be transmitted by local vectors till gametocytocidal treatment is given. **It can, therefore, be concluded that extensive use of presumptive treatment for all fever cases or clinically diagnosed malaria cases will result in rapid decline in *P.vivax* incidence in the locality, while *P.falciparum* cases will continue to increase if there are no supportive intervention measures to reduce or interrupt transmission. This is the main reason for the increase of *P.falciparum* incidence during recent past in almost all countries,** specially in those countries which have made arrangements for easy availability of a schizonticidal drug at periphery but without arrangements for administration of a gametocytocidal drug promptly. As a rule the gametocytocidal drug is given only when the results of microscopic examination of blood slides are available. Sometimes this time lag is considerable in some remote inaccessible areas. It is a fact that only very small percentage of positive cases get radical treatment to have any meaningful impact on *P.falciparum* transmission.

The entire quantum in the increase of *P.falciparum* in an area can hardly be attributed to emergence of resistant strain of *P.falciparum* to schizonticidal drugs and its unabated transmission because of resistance phenomenon.

Only different schizogonic stages of *P.falciparum* show resistance to Chloroquine or other antimalarials. **It has not been proved as yet that the gametocytes of Chloroquine resistant strains of *P.falciparum* show cross resistance to Primaquine.** In case the resistant strain is present in the community and Chloroquine is still used as a presumptive treatment, the patient will continue to have some of the schizogonic stages in the peripheral blood. The clinical symptoms will also continue till he is recognised as a resistant *P.falciparum* case and the parasitaemia is liquidated with alternative drug to which *P.falciparum* strain is sensitive. Over this period of time, gametocytes will be thrown into peripheral circulation by *P.falciparum* infection in the patient. These gametocytes, although have genetic characteristics of transmitting resistant strain through mosquitoes to human host, they themselves are sensitive to Primaquine. In case Primaquine is given well in time or along with the presumptive dose of Chloroquine to all fever cases, there will be decline in *P.falciparum* cases even in this area. If the antiparasitic measures are coupled with proper antimosquito measures, the decline in *P.falciparum* will be faster than in case of *P.vivax*.

It is a fact that in Indian programme, right from 1965 onwards, the supplies of Chloroquine and Primaquine have been erratic. Sometimes in many parts of the country, especially at the peripheral level, Primaquine was not available for treatment of microscopically positive cases of both *P.vivax* and *P.falciparum*. Apart from this, as already mentioned above, delay in slide examination as is evident by huge backlog accumulated by each of the hyper endemic districts in the country, (sometimes more than 20% slides remain as backlog and are not examined for months together) resulted in *P.falciparum* cases continuing to produce gametocytes which were transmitted by the local vectors. This is an important reason for increased incidence of *P.falciparum*.

Some other Considerations

Other characteristics of different parasite species which are likely to influence the species distribution in a community and require further study and careful evaluation are the number of gametocytes produced by *P.vivax* and *P.falciparum* infections. It has been observed that the number of circulating gametocytes in *P.falciparum* infection is always higher than those observed in *P.vivax* infection. The role of higher number of circulating gametocytes in *P.falciparum* is vitally important in determining species distribution in the locality. *P.vivax* and *P.falciparum* incubation intervals differ which are estimated at 22 days and 35 days respectively.

IMPACT OF RESIDUAL INSECTICIDAL SPRAY

The impact of residual insecticidal spray is also variable on prevalence of parasite species in the community. If the beginning of transmission is interrupted by first round of spray, the incidence of *P.vivax* declines rapidly, while second round of spray is more effective in cutting down peak transmission in hyper-endemic areas, thereby reducing the incidence of *P.falciparum* in the community.

There is a great concern about the increasing incidence of *P.falciparum* in the South East Asian countries because in the non-immune and semi-immune population groups, *P.falciparum* infection is likely to produce more serious and complicated malaria cases with accompanying high mortality.

Before conclusion, it is suggested that a detailed analysis of drug consumption, number of blood smears examined, backlog of unexamined slides, delay in administration of radical treatment, application of regular and effective intervention measures especially the second round of residual insecticidal spray operation and its impact on transmission control will confirm this hypothesis.

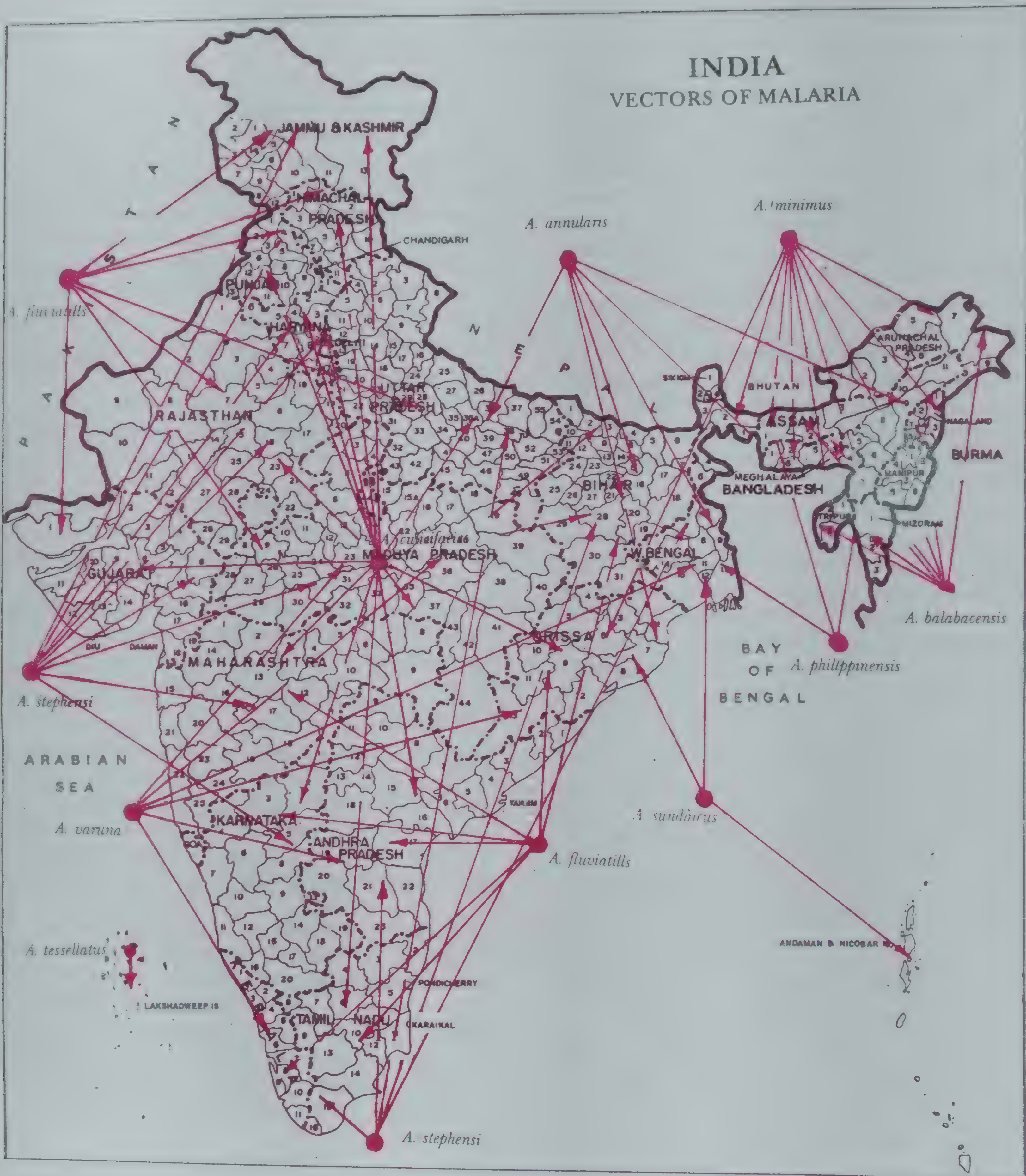

INDIA
VECTORS OF MALARIA
A. minimus
A. annularis
A. fluviatilis
A. culicifacies
A. balabacensis
A. philippinensis
A. stephensi
A. sundaicus
A. varuna
A. fluviatilis
A. tessellatus
A. stephensi
JAMMU & KASHMIR
HIMACHAL PRADESH
CHANDIGARH
PUNJAB
HARYANA
RAJASTHAN
UTTAR PRADESH
BIHAR
SIKKIM
BHUTAN
ASSAM
ARUNACHAL PRADESH
NAGALAND
MANIPUR
MIZORAM
TRIPURA
MEGHALAYA
BANGLADESH
BURMA
W. BENGAL
MADHYA PRADESH
GUJARAT
DIU
DAMAN
MAHARASHTRA
ORISSA
ANDHRA PRADESH
KARNATAKA
GOA
YANAM
TAMIL NADU
PONDICHERRY
KARAIKAL
LAKSHADWEEP IS
ANDAMAN & NICOBAR IS.
ARABIAN SEA
BAY OF BENGAL
N E P A L
P A K I S T A N

Fig- 5.20

Annexure-5.1

Bio-ecological Characteristics of the Principal Malaria Vectors in India

Name of the Vector Species	Zone of Influence	Breeding Ecology	Adult Behaviour
1	2	3	4
1. *An .culicifacies* Sibling (Vector) A	Vector of rural malaria in the North, South & Central India	Wide range: Usually breeds in water not rich in organic matter - Irrigation channels, river bed pools, tanks, ponds, sometimes in rice fields, irrigation wells, and even brackish water, hoof marks and cart tracks. (wheel ruts) rain water collection in borrow pits along rail, canal & road, rock pools.	**Resting Habitat :** Predominantly indoor rester-cattle sheds and human dwellings. Prefers cool with low disturbance places. Some may rest outdoors after spray. **Biting Time :** 1½ hours after dusk. Peak 10.30 pm. to 12.30 am **Feeding Habits** : Mainly zoophilic-Indiscriminate feeder at high density. **Flight Range :** Normally 1 km up to 3 km at high density.
Sibling (Non-vector) B	All over India except North East		
Sibling (Vector) C	East to West in the Central part of the country		
Sibling (Vector) D	Patchy in species A areas		
2. *An.stephensi*	All towns except North East; rural areas of arid/semi arid zone except in the North	**Urban areas** : Domestic & Peri-domestic water collctions and underground tanks, wells, cisterns, fountains, ornamental tanks and artificial containers ; withstands heavy pollution. Water collection on roofs. **Rural areas of Rajasthan** : Pools, stream beds, margins of streams, seepages, marshy areas, irrigation channels, etc.	**Resting Habitat :** Differs widely. Human dwellings and cattle sheds. **Biting Time :** Soon after dusk. Peak 4 am to 6 am. **Feeding Habits :** Indiscriminate feeder on human and cattle. **Flight Range :** Urban : 1 km, Rural : up to 6 kms.

Name of the Vector Species	Zone of Influence	Breeding Ecology	Adult Behaviour
1	2	3	4
3. *An.minimus*	NE States, North West Bengal	Clear slow moving water with grassy margins, swampy vegetation and little shade. In foothills it can breed in shallow earth wells and crab holes along the margins of the slow moving spring swamps, irrigation ditches, streams.	**Resting Habitat :** Prefers human dwellings -lower half of walls, on floors, under cots or on the underside of cots. Outside resting observed in Jeypore Hill tracts, etc. **Biting Time :** Peak 12 midnight - 2 am. **Feeding Habits :** Predominantly - anthropophilic, 85.7 to 92.4 per cent. **Flight Range :** About 1 km.
4. *An.fluviatilis*	Foothills all along the Himalayan range, seepages in irrigation channels	Claer water breeder, grassy margins of slow moving streams, seepages, irrigation channels, resorting to shallow wells in monsoon, terraced rice fields in Wynad of Kerala and contour drains.	**Resting Habitat :** Human dwellings, mixed dwellings and cattle sheds in some places in Karnataka, etc. In foothills, some proportion rests outdoors. **Biting Time :** Differs from area to area. Bombay : dusk to midnight with peak from 9-11 pm. Other places : 8 pm to 2 am. **Feeding Habits :** Foothills : Highly anthro-pophilic, Plains : zoophilic. **Flight Range :** 1 km.
5. *An.dirus*	Deep forests in NE region	Forest pools and streams with decaying leaves. Borrow pits along forest roads and slit trenches.	**Resting Habitat :** Exophilic, may be endo-phagic. Rests outdoors during the day **Biting Time :** Starts 10 pm. Peak 12 midnight - 2 am. **Feeding Habits :** Highly anthropophilic, 75 - 90 % recorded in Assam and W. Bengal **Flight Range :** Normally 100 metres or so.

Name of the Vector Species	Zone of Influence	Breeding Ecology	Adult Behaviour
1	2	3	4
6. *An.sundaicus*	Andaman & Nicobar Islands	Brackish waters with algae. Behind embankments protecting rice fields, tanks, cleared mangroves and lagoons. Also recorded in fresh water tanks, ponds, lakes and railway borrow pits near coastal areas. Withstands heavy organic pollution. Prefers sunlight.	**Resting Habitat :** Often in human dwellings and less frequent in cattle sheds. Outdoor resting in vegetation near breeding places, predominantly exophilic in A & N Islands. **Biting Time :** Soon after dusk, peak 10 pm to 12 midnight. At high densities may even bite during day. **Feeding Habits :** Prefers human blood. **Flight Range :** Powerful flier, about 4 km for swarming and food.

SELECTED REFERENCES

1. Bhatia, M.L. Ed. (1961): Vectors of Malaria in India. Published by National Society of India for Malaria and Other Mosquito-Borne Diseases, 22-Sham Nath Marg, Delhi-110 054

2. Nagpal, B.N. and Sharma, V.P. (1995). Indian Anophelines. Published by Oxford & IBH Publishing Co. Pvt. Ltd. 66, Janpath, New Delhi-110 001.

3. Ras, T.R.(1984): The Anophelines of India. Published by Malaria Research Centre, (ICMR), 22-Sham Nath Marg, Delhi - 110 054.

4. Sharma, V.P. and Konrdrashin, A.V. Ed. (1991): Forest Malaria in Southeast Asia. Proceedings of an Informal Consultative Meeting, WHO/MRC, 18-22 February 1991, Malaria Research Centre, 22-Sham Nath Marg, Delhi - 110054.

5. Subba Rao, S.K., Vasantha, K. and Sharma, V.P. (1988). Biosystematics of Haemophagous insects ed. M.W. Service, Systematics Association Special volume No. 37, Charendon Press, Oxford, UK.

6. Subba Rao, S.K., Nanda Nutan, Chandrahas, R.K. and Sharma V.P. (1993). *Anopheles culicifacies* complex: Cytogenetic characterization of Rameshwaram Island populations. *J.Amer Mos Control Asso.*, **9**:27.

7. Subba Rao, S.K., Nanda Nutan, Vasanta, K, Dua, V.K., Malhotra, M.S. Yadav, R.S. and Sharma, V.P.(1994). Cytogenetic Evidence for three sibling species in *Anopheles fluviatilis* (Dipter: *Culicidae*). *Ann. Ent. soc. Amer.*, **87:** 116.

6

PLANNING OF MALARIA CONTROL OPERATIONS

SECTION - 1
CONTROL OPERATIONS IN EARLY PHASES

-The disease control programme is not like any other developmental scheme where, in case of paucity of funds or inadequacy of logistic support or lack of trained man - power, the work can be slowed down or even stopped and later on resumed from the level where it was left unfinished and completed without much difficulty.

- The communicable disease control is a war against a biological phenomenon. Once started it should be continued till the goal is achieved.

AND

- Thereafter more intensified vigilance is to be maintained to prevent its resurgence.

IF EFFORTS ARE SLACKENED

- The environmental factors tend to revert to original state of equilibrium and the disease transmission will recommence.

- The politicians, administrators, financiers, implementing organisations and the community have witnessed malaria resurgence all over the globe due to their complacency in control or maintenance efforts.

REMEMBER THIS WARNING

- If malaria control activities suffer from further negligence and lacunae, more intense epidemics with high mortality and morbidity will be witnessed in malarious areas.

- If nothing is done today, by 2001A.D. malaria will affect nearly half of the world population decimating or incapacitating about2% of them in the endemic areas.

- The economic and industrial development in the third world where malaria is rampant will be adversely affected.

- Any temporary palliative effort is doomed to an early failure.

THEREFORE

- Community should rethink and implement sustained malaria control programme on long term basis irrespective of the cost involved.

- There should be adequate flexibility in the programme to take care of altered behaviour of biological species involved in the disease process.

INTRODUCTION

Malaria has been universally recognised as an important public health problem. The Malaria Commission of the League of Nations (1930) estimated that one third of the global population suffered from malaria and it was still true in 1993 - out of 5.4 billion, 2.2 billion of the humanity was exposed to malaria. An estimated 300 to 500 million cases of malaria occurred with about 0.5% to 1% mortality. The adverse impact and human suffering afflicted by malaria was most intense among the poor communities in rural areas. The ravages of malaria had most severe adverse impact on agriculture community. The industrial progress and other developmental projects also suffered on account of malaria. Prior to discovery of malaria transmission by Sir Ronald Ross, the malaria control activity centred around treatment of malaria cases and prevention through chemoprophylaxis with Quinine so much so that the Third International Congress on Tropical Diseases and Malaria in Amsterdam during the year 1938 mostly concerned itself with laying down standards for Quinine decoction - Totaquina for treatment and prophylaxis of malaria. Only after the discovery of malaria transmission by Sir Ronald Ross in the year 1897, its control by attacking the breeding places of anopheline was formulated. A number of historically well known control measures were initiated. These measures met with varying degrees of success. Some of the outstanding examples are malaria control in Free Town in Sierra Leone, Lagos in Nigeria, Mian Mir in Punjab (Pakistan), Malaya, Hongkong, Ismailia (Suez Canal town) and Panama Canal area. In Algeria, Sergent brothers worked on the control of malaria while in Italy, Celli and Marchiafava began organised systematic campaign for control of malaria.

Almost all these campaigns were based on water management and prevention of vector breeding through antilarval operations in the control area. In India, the control measures were initiated in areas of economic importance and where military and para-military personnel were located, such as Cantonments. The tea gardens in Assam and West Bengal, areas where Railway Construction was in progress and metropolitan cities like Bombay were covered due to their economic importance. In thirties, it was clearly demonstrated that along with antilarval operations, a weekly space spraying with pyrethrum was more effective in controlling malaria in a malarious area. The space spray with pyrethrum was also found to be effective in controlling malaria in rural areas.

It is interesting to note that during the early years of the century, Celli saw the disease and its close association with man as a social problem, while Ronald Ross and Gorgas thought of malaria control in terms of its military importance.

Antilarval measures were the only control technology available for malaria control. These measures were implemented in various malarious areas all over the world. The water management was an important aspect of Tennessee Valley Development. In India Sarda Canal project was an outstanding example of what could be achieved with proper water management and antilarval operations in spite of high malaria endemicity.

MALARIA CONTROL WITH ADULTICIDES

During the third and fourth decades of this century, pyrethrum space spray was added to the armaments in the fight against malaria which had an added advantage by way of its action against other mosquitoes on account of its knockdown effect. In India, the residual insecticides were introduced for malaria control in the Armed Forces in 1944. DDT became available for civilian use for antimalaria operations in 1945. In the beginning different formulations were tried in India such as solution, emulsion, water suspension and water dispersible powder. The results of the pilot studies were encouraging. In the Indian climate residual effect of insecticide lasted for 6 to 8 weeks in most of the rural areas. In some of the studies, the residual effect was observed for a period of ten weeks. In areas under the influence of *An.fluviatilis*, the residual effect was found to last for three months. Similarly in *An.minimus* areas, the single round of DDT spray was found to be

effective for a period of eight weeks. These results encouraged the Indian malariologists to take up demonstration studies with DDT for malaria control in different paradigms of malaria during the period from 1945 to 1952.

The other governmental and semi-governmental organisations such as Defence Forces, Railways, Coalfields and Multipurpose River Valley Developmental Projects had set up their own malaria control units and used residual insecticidal spray for malaria control. Some of the demonstration projects were taken up with the help of international organisations like WHO/ UNICEF, Rockefeller Foundation, etc. List of these projects is given in Table- 6.1.

TABLE - 6.1: PILOT PROJECTS PRECEDING NMCP - 1946 - 52

ANDHRA PRADESH:

1. Coalfields (1946-52)
2. Tirumala, Chittoor District (1947) DDT sol. spraying.

ASSAM:

1. 30 highly endemic areas (1949) DDT
   - Tea Estates in Kamrup District
   - Sibsagar District, Manians
2. Margherita Coalfields (1945-52)

BIHAR:

Jharia & Hazaribagh Coalfields (1945-52)

DELHI:

- (1947): DDT spray/Antilarval

GOA:

- (1949): DDT House-spraying

GUJARAT:

- Ahmedabad (1950) - DDT spraying

KARNATAKA:

- Puttar Taluka (S.Kanara), (1947-48)

KERALA:

- Wynad - WHO/FAO Pilot Project
- Malnad - WHO/FAO Pilot Project

MADHYA PRADESH

1. Kanker Town and 21 villages - (1952) DDT/ BHC spray
2. Coalfields, Panch Valley and Chanda (1945-52)
3. Shivpuri District

MAHARASHTRA:

(Erstwhile Bombay Presidency).

- Dharwar District, Belgaum

ORISSA:

WHO Demonstration Pilot Project-Jeypore Hill Tracts (Rayagada)

UTTAR PRADESH:

WHO/FAO Pilot Project : Nainital District (1949-52)

WEST BENGAL:

1. Raniganj Coalfields (1945-52)
2. Bankura District Malaria control (1950) - DDT spray
3. Birbhum District Malaria control (1951) - DDT spray
4. Hooghly District Malaria control (1952) - DDT spray
5. Nadia District Malaria control (1952) - DDT spray
6. Jalpaiguri - Tea Estate areas (1947) - DDT spray

NATIONAL MALARIA CONTROL PROGRAMME

Excellent results obtained under the Pilot Projects of Malaria Control using DDT indoor residual spray operations and the cost effectiveness of the residual insecticidal spray for malaria control in rural areas led the Government of India to launch a National Malaria Control Programme. The objectives of the programme were:-

i. To bring down malaria transmission to a level at which it would cease to be a major public health problem.

ii. Thereafter an agency was to be maintained by each State to hold down malaria transmission at low level indefinitely.

As far back as 1946, the priority to malaria control was given by Health Survey and Development Committee (Bhore Committee). The Committee stated '**Malaria control programme should receive top priority. It should be carried out through a Central organisation in co-operation with the States. Selection of area in the first instance should be based on their food production capacity and hyper endemicity and approximately 50% of the population should receive protection within the first two years'**. They went on to record further '**creation of an organisation at the Headquarters of each province and establishment of a number of malaria control units each under a medical officer especially drawn for antimalaria work for operating in the affected areas in different parts of the Province'**. In 1951, Planning Commission reviewed the question of malaria control on country-wide basis and fully endorsed these recommendations. In 1952, Malaria Control was supported by Scientific Advisory Board of the Indian Council of Medical Research. The programme was launched in April, 1953. It was drawn up by Malaria Institute of India in consultation with WHO, UNICEF and other bilateral organisations like Rockefeller Foundation, Technical Co-operation Mission (USA). The State Malariologists of Antimalaria Organisations were also involved.

The principal activities under the Malaria Control Programme comprised of :-

i. Residual insecticidal spray of human dwellings and cattle sheds.

ii. Malaria control teams of the State Malaria Organisation were to carry out surveys and monitor the malaria incidence in the control area.

iii. No organised chemotherapeutic measures were taken up under the control programme but wherever the patient reported to a medical facility, drug was made available for treatment of malaria. In the first five years (1953 to 1958), the target was to establish 125 Malaria Control Units each protecting one million population. Under the Malaria Control Programme, 165 million population was protected and there was general reduction in epidemiological parameters-about 62% in infant parasite rate and 73% in child parasite rate in most of the areas where control operations were carried out.

MALARIA ERADICATION PROGRAMME

Concept and Objective

At first, reports were received from other countries indicating that some of the culicine mosquitoes had developed resistance to DDT. Later resistance to DDT was observed in anopheline mosquitoes in 1951 in Greece. In the beginning though report of DDT resistance in anopheline mosquitoes was from outside the continent, it was apprehended that very soon DDT resistant strains would also be selected in this country. In this context the change in the concept from malaria control to malaria eradication was discussed in 1955 in the Eighth World Health Assembly and the following resolution was passed:-

'Requests Governments to intensify plans of nation-wide malaria control so that malaria eradication may be achieved and regular insecticide spraying campaigns safely terminated before the potential danger of development of resistance to insecticides in anopheline vector species materialised.'

At the ninth Regional Committee session of the South-East Asia Region of WHO held at Delhi in 1956, the question was again considered and eradication of malaria was accepted as a goal for all the countries of the region.

The Sixth WHO Expert Committee in 1956 defined malaria eradication as '**the ending of the transmission of malaria and the elimination of the reservoir of infective cases in a campaign limited in time and carried to such a degree of perfection that when it comes to an end there is no resumption of transmission'.**

The malaria eradication policy enunciated by WHO had four phases **i**. Preparatory, **ii**. Attack **iii**. Consolidation as part of a vertical programme of malaria eradication. Thereafter, the last phase of **iv**. Maintenance was to be the responsibility of General Health Services of the State.

Preparatory Phase

The Preparatory phase has generally three sub-phases.

a. Initial survey.

b. Planning

c. Preliminary Operations

a. Initial Survey

The initial or pre-eradication survey is undertaken and should be as complete as practicable. Purpose of this survey is to delimit the malarious areas of the country and to help in determination of the order in which various malarious zones will be brought under the eradication programme. These surveys provide basis for administrative action in planning of the spray operations.

b. Planning

The planning of eradication project must take into consideration not only the characteristics of the problem as delimited by the surveys but also the existing facilities for implementing Attack phase of eradication programme. The schedules and estimates of operations should be prepared covering such essential items as personnel, supplies and equipments, transportation, budget and timetable of eradication programme.

c. Preliminary Operations

Preliminary operations should include recruitment and training of staff at all levels, preparation of manuals, working procedures and other essential documentation, setting up of administrative boundaries, enumeration of houses to be sprayed, itinerary for procurement and transportation of supplies. In case such exercises have not been done earlier under control programme, it is essential to take them up before initiating main Attack phase of eradication programme.

Attack Phase

i. The Attack phase envisages total coverage with residual insecticides or antilarval operations where technically indicated for cessation of malaria transmission

ii. Along with the above, case detection and treatment for liquidation of malaria reservoir.

In some areas for special reasons, antilarval measures may be required, so also the use of antimalarial drugs. The extent and use of these methods will depend on local conditions.

Absolute freedom from malaria foci is not necessarily obtained in this phase but this is achieved within the next phase of the eradication programme i.e. Consolidation phase.

During this phase a system of assessment and evaluation of results should be built-in and carried out from time to time to measure what has been achieved and what remains to be achieved.

Introduction of Surveillance Mechanism during Attack Phase

During Attack phase, a surveillance system is organised. The active case finding by house to house visit or by other effective method is required as soon as the reservoir of infection is sufficiently diminished. It is usually introduced after the first year of total coverage.

The surveillance facilitates quick recognition of residual and previously unsuspected foci and leads to recognition of impact of control measures on transmission.

Consolidation Phase

During surveillance system, public co-operation especially from medical profession may also be sought for detection of malaria cases.

Case Detection - Surveillance System

Comprehensiveness and efficiency of case detection mechanism are to be judged by:

a. Proportion of population covered and relative proportion of cases found by active and passive detection.

b. Number of slides examined (at least equivalent to 1% of the population per month during the months of malaria transmission).

c. Distribution of source of slides showing reasonable total coverage of all erstwhile malarious areas.

d. Efficiency of supervisory activities specially in active case detection mechanism as seen from the records of the supervisors.

e. Efficiency of active case detection mechanism as indicated by the periodicity of surveillance worker's visits. It also emphasised reliability of microscopically diagnosed cases as revealed by all over check/cross-check.

Thoroughness of epidemiological investigation and classification of epidemiological situation require **a**. existence of correct records showing detailed investigation carried out on each confirmed malaria case, **b**. evidence that these records were scrutinised at each level, **c**. adequate number of blood slides taken in the neighbourhood of each case, **d**. existence of registration of all malaria cases discovered during Consolidation phase and these records were maintained.

Maintenance Phase

This phase would last as long as malaria exists in the world.

The Health Department should add malaria to the list of non-endemic diseases, for which it is always on alert and the disease would remain notifiable and any imported or indigenous case should be notified as a routine method by the Health Department. It should be the duty of the General Health Services to maintain malaria - free status of the malarious areas which have entered this phase after going through Attack and Consolidation phases.

Principal activities to be carried out by General Health Services of the country are:-

i. To maintain vigilance activities through suitable case detection machinery to prevent entry of a malaria case.

ii. To detect as quickly as possible the entry or occurrence of a malaria case through case detection organisation fully equipped to confirm the microscopic diagnosis.

iii. To carry out epidemiological investigation for establishing limits and extent of the focus detected.

vi. To undertake remedial measures such as focal insecticidal spray, mass chemotherapy and radical treatment of positive cases to liquidate the focus.

v. To redouble the vigilance to prevent recurrence of malaria outbreaks in the same area.

NMEP - INDIA

The Malaria Eradication Programme was launched in India in 1958. It showed spectacular success and by 1965 the annual malaria incidence fell from 75 million cases to an all time low of 0.1 million cases. No deaths were recorded. In other words in one year alone i.e. 1965 the programme prevented nearly 100 million cases and about 1 million deaths due to malaria according to rough estimate. Total malaria cases prevented since 1958 over seven years may have been in the range of 500 million cases and five million deaths which is a spectacular achievement by any standard. From 1968 onwards there were setbacks, 91 million population was involved in resurgence and reverted to Attack phase. By 1976 highest ever post-eradication incidence of 6.47 million cases was recorded.

In 1977 the attempts at malaria eradication were given up and under the revised policy, a Modified Plan of Operation was adopted.

The Eighth Expert Committee on Malaria - WHO 1960 identified the causes of failure under Malaria Eradication Programme and generally grouped them under technical failure, imperfect

recognition of all variables of local epidemiology of malaria, errors in selecting the methods for interruption of transmission and deficiencies in planning.

In the Indian Programme, the major causes can be listed as under:-

i. Lack of appreciation of Malaria Eradication Programme by the Government resulting in:-

a. Inadequate budget

b. Delays in making funds available

c. Lack of provision of funds for emergencies.

ii. Routine administrative interference with the implementation of the programme.

iii. Lack of co-operation of other departments.

iv. Lack of appropriate legislation to enforce proper implementation of the programme.

v. Absence of autonomy and flexibility.

vi. Delays in recruitment of personnel.

vii. Delays due to failure of logistics.

viii.Interference from authorities not connected with programme implementation.

ix. Unattractive salary to the trained staff.

x. Cuts in budget during operational phase and uncertain future of the NMEP staff.

xi. General apathy of the Government i.e. the State general health infrastructure towards giving appropriate priority to malaria control.

xii. Non-acceptance of control operations by the community because it was no longer their felt need as was prior to 1958.

However, in order of importance the following factors contributed to the failure of NMEP:-

i. Disruption in supplies of insecticides received under bilateral assistance in the wake of Indo-Pakistan War in mid-sixties.

ii. Slow development of infrastructure in maintenance phase areas despite recommendations of the Chadha Committee, 1963.

iii. Inadequate surveillance in time and space resulting in delayed remedial measures around re-established foci of transmission involving larger areas and focal outbreaks.

iv. Inadequate financial allocation and delayed release of funds to the periphery.

v. Administrative bottlenecks in augmentation of the peripheral staff needed to strengthen the field operations to meet the requirements of the area based on the epidemiological profile of malaria.

vi. Although precipitation of insecticidal resistance in the vector did have adverse impact on malaria eradication activities, it was not serious enough to produce setbacks as observed during 1968 to 1976.

vii. The problem was further aggravated by a large number of developmental projects including River Valley Irrigation Projects, Road construction, Railway construction, etc. resulting in creation of mosquitogenic conditions and tropical aggregation of labour for implementation of the projects creating conditions conducive to focal epidemics of malaria. The project authorities did not preplan measures for control of malaria during construction phase of the project. From these areas, there was dissemination of malaria to surrounding rural areas.

MODIFIED PLAN OF OPERATION

Objectives:

i. Prevention of deaths due to malaria.

ii. Reduction of morbidity due to malaria.

iii. Maintenance of industrial and green revolution due to freedom from malaria as well as retention of achievements gained so far.

Main Activities:

The programme covers all States and Union Territories. The three main activities are executed by the State Govts./UTs namely:

i. Insecticidal spray with appropriate

insecticide during the transmission period in rural areas recording API 2 or above.

ii. Fortnightly blood smear collection by domiciliary visits from fever cases, their examination, treatment of fever/malaria cases with antimalarial drugs.

iii. In urban areas, recurrent antilarval operations to be undertaken.

iv. Attempts were made to intensify these efforts in rural areas in identified districts through Swedish International Development Authority (SIDA) by providing additional inputs under PfCP.

v. Decentralisation of laboratory services to the PHC level.

vi. Establishment of DDCs/FTDs.

In the first few years of Modified Plan of Operation, it was a 100% Centrally sponsored programme and decentralisation of laboratories to Primary Health Centre level, selective spray on API criteria, establishment of Fever Treatment Depots (FTDs) and Drug Distribution Centres (DDCs) to strengthen surveillance and ensure early availability of antimalarials at the village level for treatment of malaria cases gave very good results. The malaria incidence came down. Later on the malaria surveillance was entrusted to multipurpose worker (MPW) under primary health care system (PHC), Malaria surveillance worker became a part of PHC organisation. Under the PHC system malaria got the lowest priority. Fever surveillance became monthly. Because of lack of contact with FTDs and DDCs these became defunct. With the passage of time experienced workers at the periphery retired. The programme expenditure was shared on 50:50 basis between States and the Centre from 1979-80 onwards. Due to uncertainty about availability of funds, MPW (M) posts were either not created or not filled. This situation resulted in delayed or non-detection of malaria cases during transmission season and thus delayed or no Radical Treatment to positive cases. The adverse impact of delayed RT or no RT to *P.vivax* did not create an operational problem but in case of *P.falciparum* its transmission continued unabated. Therefore *Pf%* all over the country showed a rise. If this trend continues, by 2001 A.D. there will be more than 90% vacancy in MPW (Male) cadre and case detection under malaria will come to a standstill. Sharing of expenditure had a very adverse impact on logistics i.e. purchase of insecticides, spray equipment and other items like microscopes and transport for replacing the old condemned equipment.

These factors retarded the early success of the MPO for the last ten years or more. The annual incidence of malaria is about two million positive cases over the last one decade but it is likely to be much higher on account of poor case finding and delayed treatment and virtual absence of insecticidal spray in some areas. All over the country some explosive outbreaks occurred and high mortality among partially immune population in traditionally low API areas was recorded.

These setbacks are not unique to Indian programme alone but have been recorded in almost all malarious areas of tropical countries.

SECTION - 2
CURRENT MALARIA CONTROL POLICIES

During the last 20 years, there were three important policy changes with regard to community health and health delivery system. The **Alma Ata** Conference in **1978** agreed on Primary Health Care System as basic approach to achieve the goal of 'Health for all by 2,000 A.D. In the wake of this declaration and keeping in view the social goal of Health for all by 2,000 A.D., India gave emphasis on development of Primary Health Care System. Later on modified plan of NMEP was integrated with the Primary Health Care System. In 1979-80 the malaria control operations were carried under 50:50 sharing pattern between the States and the Centre. The changeover to PHC system and integration of malaria surveillance and decentralization was gradual and the States took several years to implement full integration. The domiciliary visits by surveillance workers under the vertical malaria eradication programme were transferred to the Multipurpose Workers of Primary Health Care System.

In retrospect, it is now quite evident that malaria control measures including early case detection and intervention measures for transmission control are of a very complex nature. They have to be implemented properly in a specific time frame in all communities exposed to malaria risk. The control measures have to be flexible catering to the epidemiological and ecological needs of the area. How far the Primary Health Care System developed in this country is mature enough to be organisationally and technically sound enough to cope up with the malaria problem is yet to be seen.

The next policy decision came through a Resolution of **World Health Assembly in 1989.** They had indicated that **malaria control should be global priority** in the health sector and appropriate human, scientific and financial resources should be mobilised for the same. In this declaration, no change in the health delivery system was indicated. Latest policy decision was made in 1992 in the **World Declaration on Control of Malaria (Ministerial Conference - October 1992)**. The Conference after reviewing the malaria scenario in the world came to the conclusion that **malaria, a communicable disease, should not be an inevitable burden on the community.**The malaria can be curbed with the present tools by the local health system as has been shown by some countries. **They emphasised that the centralised control programme should be more flexible, cost-effective, sustainable and adopted to local conditions.** To achieve this goal they recommended that it was necessary to gradually develop national and local capacities for assessing malaria situation and selecting appropriate control measures. They were of the opinion that in the great majority of countries, malaria eradication might not be a realistic goal but an approach should be made to control malaria. The emphasis was also placed on community participation and intersectoral co-ordination between health and other departments whose projects created malariogenic conditions in the area.

The four basic technical elements of the strategy suggested are:-

- To provide early diagnosis and prompt treatment (EDPT).

- To plan and implement selective and sustainable preventive measures.

- To detect early and contain/prevent epidemics and

- To reassess regularly country's malaria situation, in particular the ecological, social and economic determinants of the disease.

In this declaration, it is emphasised that **there is no single solution to malaria problem** but broad guidelines of approach for achieving malaria control were suggested.

WHO document on global malaria control strategy - 1992 has identified two categories of countries :-

Category I countries:- African countries south of Sahara where there are no organised malaria control programmes.

Category II countries:- Countries which have/had disease prevention activities including vector control through organised malaria control/eradication.

Priorities for strengthening malaria control programme for each category as suggested by WHO are reproduced in Table- 6.2 and Table- 6.3.

Table- 6.2 : Priorities for Strengthening of Malaria Control Programme

Structural component	Category I countries	Category II countries
Funding	Needs substantial increase, but within overall health planning	Modest investments can lead to better cost effectiveness and long-term savings.
Collaboration with general health services	**Implementation mainly through general health services.** Disease management may need to be extended beyond coverage of existing formal health services.	**Programme capabilities should be used for strengthening general health services for taking full responsibility for diseases managements**
Epidemiological information system	Must be strengthened, **initially by use of hospital and sentinel data. Local analysis of data by general health services needed.**	**Must be based on generel health services data.** Must be used dynamically for targeting intervention
Special services for vector control	May need to be established in some countries with risk of **epidemics. Special technical, managerial and logistical support needed if impregnated nets will be used.**	Need to be determined, and better managed. Improved targeting of activities needed. In some areas, impregnated nets should be adopted instead of house spraying
Intersectoral collaboration	**Requires technical strengthening of control programme involvement of relevent sectors in planning,** increasing awareness in different sectors, and high-level political commitment.	
Staff	**Increase in number. Training in epidemiology, management, operational research.**	Increase in ratio of qualified professional to medium and unskilled staff.

Later on, they divided the areas into different paradigms of malaria giving epidemiological characteristics, suggested operational approach for malaria control and action required for disease management and prevention.

Table- 6.3. Actions Required to Improve Malaria Control in Different Malaria Situations

Malaria type (Main occurrence)	Characteristics		Action required	
	Epidemiological	Operational	Disease Management	Prevention
1	2	3	4	5
Savanna malaria [e.g. Africa South of Sahara, Papua New Guinea]	**-Perennial transmission; with seasonal variations away from equator** *P.falciparum* is overwhelmingly predominant * Morbidity and mortality mainly in young children and pregnant women. * Expansion of drug resistance	**Insufficient coverage by health services.** Malaria Control Programmes most often rudimentary	**. Expansion through formal and informal general health services.** **. Capacity for management of complicated malaria and treatment failure in health services.**	* **Investigation on potential role of impregnated bednets and curtains** * **Chemoprophylaxis for pregnant women,** unless precluded by drug resistance
Malaria of plains and valleys outside Africa [e.g. Central America, China, Indian subcontinent]	.Variable, mainly moderate transmission .*P vivax* may predominate. **. Strong seasonal variation.** **. Risk of epidemics.** **. Drug resistance** generally well establised.	**. Large-scale insecticide spraying Programme often ineffective** . Inadequate disease management. **Insufficent general health services and private services in some areas.**	Responsibility for diseases management to be assigned to general health services. **. Establishment/ strengthening the epidemiological information systems.**	**. Reorientation for better targeting of vector control.** . Environmental management in some areas. . Use of impregnated bednets (proved useful in China).
Highland and desert fringe malaria [e.g. African and South-East Asian highlands, Sahel. Southern Africa, South West Pacific].	**Risk of epidemics due to climatic aberrations, changing agricultural practices or because of migration to malarious areas.**	. Presence of health services variable. **. Preparedness for management of malaria cases may be poor in habitually malaria-free areas.**	**. Facilities to be established rapidly with effective drugs in case of outbreak.** **. Active detection and treatment of fever cases may be justified.** . Health services must be aware of risk of outbreak.	**. Insecticide spraying can often rapidly curb transmission and sometime restore malaria-free status.**

1	2	3	4	5
Agricultural development projects [e.g. Asia, South America, Africa]	**. Increases transmission due to irrigation in certain circumstances.** **. Risk of seasonal malaria outbreak due to attraction of non-immune labourers.**	. Often insecticide resistance in cotton growing areas . Some financial resources are available for malaria control	**. Services for early treatment to be established / strengthened.**	. Environment management to be considered at the planning stage. **. Siting and screening of dwellings** **. Impregnated bednets.** **. Larvivorous fish in some rice-growing areas.** **. House spraying or chemoprophylaxis if needed.**
Urban and periurban malaria (e.g. Africa, South America, South Asia Sahel, Southern Africa, South West Pacific).	Transmission and population immunity highly variable over short distances. **. Epidemics caused by specially adapted vectors in South Asia.**	**Relatively good coverage by health services.** **. Variety of anti-malaria drugs available from different sources.** . High population density. **. Breeding sites identifiable**	**.Standardisation or harmonisation of treatment practices.**	**. Larval control, in some situations chemical larviciding is preferable.** . Personal protection.
Malaria of forests and forests fringes [e.g. South-East Asia, South America]	**. Focally intense transmission.** **. Often occupational risk groups.** **. Severe multi-drug resistance.**	**. Health services absent or poorly developed.** . Absence of social organisation. . Variety of drugs sold. **The benefits of house spraying and larval control are questionable**	**.Facilities must be established where needed, may need to be specialised for malaria.** .Treatment protocols must be continually adjusted on basis of operational research.	**.Personal measures** should be used. .The use of impregnated bednets may be considered

Later on, WHO had appointed a study group to provide guidelines for implementing malaria control strategy. This Committee examined all the four basic technical elements of global malaria control strategy. After studying the malaria situation in different regions such as African Region south of Sahara, and the regions of Asian and Latin American countries with malaria problem, again emphasised:-

i. Political commitment and national policy for implementing malaria control as part of primary health care system.

The action required column in Table- 6.3 should be carefully read. The portions in bold are applicable to Indian conditions. Strengthening of PHC system is a must with special extra inputs.

ii. Ensure proper disease management by the general health services.

iii. Recording of malaria morbidity and mortality should be a part of general health services.

iv. Epidemiological data should be more judiciously used in targeting intervention measures for vector control/transmission interruption.

v. Training at various levels in programme management, health care delivery and epidemiology.

For this purpose, they envisaged long-term technical assistance to countries with malaria problem; emphasised research on development of new drugs for treatment of multi-drug resistant strains of malaria parasite. For effective planning of malaria control operations, they were of the opinion that :-

Professionals with knowledge of malaria as a disease should select malaria control strategies and intervention measures keeping in view the local conditions.

Professionals in sectors other than health whose activities are likely to influence malaria endemicity of the area should also be involved while developing control strategy.

In respect of disease management, they gave emphasis for diagnosis and treatment of malaria and formulation of a national malaria drug policy.

The **'disease managment'** has different connotation in respect of different diseases and in some cases even more than one. In case of malaria not only **'disease load'** but also **'disease potential'** is to be taken into consideration.

In case of diseases like tuberculosis or leprosy, it may be as simple as case finding and treatment of a case to make him symptom free and non-infective in as short a period of time as possible, to prevent transfer of infection to contacts so that over a period of time disease load in the community is reduced to a level at which large scale transmission is not possible.

A similar concept is not applicable to malaria as the 'Malaria Transmission Dynamics' are more complex.

'Disease load' and **'disease process'** in a community in case of tuberculosis and leprosy have only three dimensions namely, **i.** number of infectious cases in the community, **ii.** number of susceptible persons and **iii.** probability of an infectious case infecting a susceptible person in a unit period of time. In the case of malaria, it is slightly different - the **'disease load'** or **'disease potential'** in the community is governed by different parameters, such as number of **'infected persons' 'susceptible persons'**, **'vector'** and **'environmental conditions'**. Here, parasite factor is not given primary importance as the infection in an individual when detected can be controlled by available chemotherapy.

1. The **'infected person'** suffers from clinical attack of malaria but is not directly infective to any other person in the community while he is capable of infecting a vector mosquito.

2. The infective mosquito is infective to a susceptible person. The infectivity of mosquito is modified by its previous exposure to serum of a person with low immunity - potentiation of sporogony. On the other hand, vector exposure to hyperimmune human serum retards the sporogony.

3. The environmental factors influence the **'longevity of vector'**, thus governing the number of persons a vector may infect in its life time.

Therefore **'disease management in case of malaria is substantially diffrent from that advocated for diseases like tuberculosis or leprosy'**.

In the case of malaria the **'case detection and its treatment'** is not the end of all endeavours. The **'liquidation'** of infective vector population or **'prevention of infection'** to vector by a mix of intervention measures is another aspect of equal importance, if not more.

The concept of sustainability of all these measures also has many interpretations.

i. Sustainable through the efforts of the Governments of the countries.

OR

ii. Sustainable through the joint efforts of the Governments and the community, both being equal partners.

OR

iii. Sustainable by community efforts alone.

The above situations include financial, organisational and executive aspects. Another dimension of **'sustainability'** is the

- **'sustainable technical inputs'**

- How long and of what intensity of measures can give effective control/management of the disease ?

- Is the technology long lasting or will it fail to contain the **'disease load'** in the community within a short space of time ?

The magnitude and intensity of the intervention measures are inter-dependent on these factors as perceived by programme administrators or executors at the peripheral level as well as the community involved. This should not deter the malariologist from suggesting the optimal measures to be applied, with reasonable cost and methods of surmounting the operational difficulties likely to be encountered in the course of programme implementation.

If there is paucity of financial resources, alternatives can be suggested keeping in view which measure is essential to reduce morbidity and mortality to acceptable level without an adverse effect on malaria disease profile at a future date, for example selection/development of foci of Chloroquine resistance of *P.falciparum*, etc.

Because it is well-known, and no one can deny that the equilibrium between 'Malaria and Man' is obtained at a very high 'Human Cost'. The 'children and women' specially pregnant women, pay heavily in terms of morbidity, mortality, incapacitation and hence risk to other diseases due to broken health.

Further, it is also a well recognised fact that in the intensive transmission area with *P.falciparum* predominance, those children who survive to adulthood may have marked psychosomatic changes produced by chronic *P.falciparum* infection and asymptomatic parasite carrier status. This affects mental and physical capability, thus affecting 'physical and mental output', life-style, and 'social outlook' thereby modifying behaviour as constructive members of the society.

This is more aptly applicable to tribal communities living in difficult areas where *P.falciparum* is the dominant species.

Further, every citizen of India can now demand and enjoy a right to appropriate treatment of malaria, if he suffers from this disease. This right of the individual is enshrined in the WHO declaration adopted by the ministerial meeting in malaria in Amsterdam (1992). As a corollary to the right to treatment, the concept can be extended to the right to freedom from subsequent infections with malaria. This preventive aspect assumes greater importance in the light of the facts brought out in the para above.

Recommendations of the Study Group on EDPT

Early diagnosis and prompt treatment of malaria cases can be achieved through several alternative approaches and are governed by the condition or stage of development of health infrastructure in a country. They are:-

i. Individual Seeks Early Treatment of Malaria

In most of the poor countries, failure by the patient or his family in recognising the need of immediate medical aid for treatment of a fever episode sets the pattern of utilisation of health services in the locality. This pattern is modified by the belief and custom of the local community as regards to the causes of fever, its impact on health and remedies available locally under the system of medicine like Ayurvedic, Homeopathic, Unani or even with traditional healers. By nature, the malaria episode is an acute disease with sudden onset. If the periodicity is well-established, a fever free period where the patient feels normal, results in postponement of seeking prompt medical aid on the part of the patient.

ii. Fever Case Detection and Treatment through Voluntary Agents

In other circumstances, the health delivery system can establish voluntary post(s) in the locality where a fever case receives antimalarials on demand and under this system also the same constraints operate as seen under the first option i.e. community and individual attitude towards fever.

iii. Active Case Detection by Health Delivery System

Under the two options given above, the onus of seeking medical aid lies on the patient or his family. There are countries or areas with a well organised Primary Health Care Delivery System with a provision for domiciliary visit to each household. Here the fever cases are under surveillance at periodic intervals, say fortnightly and those having fever or who had fever in between the visits are given antimalarial treatment. Some of the countries provide a facility for blood smear collection along with antimalarial treatment.

In malaria the disease is acute and any delay in proper diagnosis of a case or administering treatment may result in mortality. In malaria paradigms where *P.falciparum* infection is predominant, the serious complications leading to high mortality may occur within a matter of a few days and here lies the difference between disease management of malaria and other communicable diseases.

All the experts do agree that prevention of morbidity and mortality due to malaria can be achieved by early case diagnosis and prompt treatment.

Problem of Mortality

A large number of deaths due to malaria have been reported from various parts of the world. The mortality due to malaria alone is estimated at 1.4 to 3.2 million cases per year in a population of 2.2 billion exposed to malaria risk. In India, the mortality figures range from 300 to 400 cases per year. In areas with malaria epidemic, very high mortality is recorded. Some authorities estimate that in India the malaria mortality rates are 60,000 to 70,000 per year. This has already been discussed in the Chapter-2 on measurement of malaria but the fact that high mortality due to malaria observed in non-immune population such as infants and young children cannot be ignored. Under the normal surveillance procedure and case detection mechanism, whether it is community oriented or through the governmental agencies, there is a gross under-reporting of mortality in children and infants.

Morbidity

The morbidity due to malaria can affect the community and individual in many ways **i.** the period of morbidity in an individual with malaria (i.e. number of sick days) can be reduced by early case diagnosis and prompt treatment **ii.** reduction in the number of malaria cases reported from a community can be achieved by giving prompt radical treatment to liquidate peripheral gametocytaemia in malaria patients. The radical treatment of malaria cases reduces malaria transmission in the locality.

For the reasons given above, if a country has an adequate, well-organised, peripheral infrastructure under the Primary Health Care System to perform periodic but regular domiciliary visit, the best results of EDPT can be obtained by active case detection, prompt examination of blood smears and administration of radical treatment for parasitological cure of the patient.

Under the Indian programme, the active case detection is carried out by MPW (male) under Primary Health Care System. The fortnightly periodicity of domiciliary visit suits the technical requirement of malaria disease management. By fortnightly surveillance, a large number of secondary cases can be avoided in the community where malaria transmission is seasonal but well - established. Components of the activities under the active case detection during fortnightly visit are:-

i. Search for a fever case or a case who had fever in between the visits of MPW.

ii. Collection of blood smear from such cases

iii. Administration of appropriate antimalarial(s)

Some experts may object to the active case detection including collection of blood smears because this system is not emphasised under the new global strategy for malaria control by WHO. However, they have laid down that the countries which have got adequate infrastructure may continue to collect blood smears and microscopically examine them for estimation of malaria incidence in the community. The data can be utilised for planning of malaria control operations. If the country has an adequate peripheral infrastructure under the Primary Health Care System, it can be utilized with advantage for prompt radical treatment of malaria positive cases which will result in keeping *P.falciparum* incidence in the locality under check. The justification for continuing the domiciliary visits under the Indian context lies in the fact that:-

i. The Primary Health Care System provides one MPW (male) for 3,000 population in hilly and tribal areas and for 5,000 population in other areas.

ii. The manpower envisaged under the plan is adequate to cater the needs of the active case detection for malaria control.

iii. However, to avoid delay in detection of cases which occur in between visits, it can be supplemented with establishment of Fever Treatment Depots in villages specially in areas which are remote/inaccessible and have low population density, for example villages in hilly terrain and also villages in arid areas of Rajasthan and Kachchh Bhuj.

iv. Blood smear collection is necessary to have parasitic confirmation, especially in view of the fact that large areas in the country have predominant infection with *P.falciparum*.

v. There are some areas of *P.falciparum* with R II and R III level of resistance to Chloroquine. In these areas, the treatment with alternative drugs is given to *P.falciparum* case on microscopic confirmation of the diagnosis. Indiscriminate use of second line drug(s) under the presumptive treatment is always disastrous and precipitates the multi-drug resistant strains of *P.falciparum*. Therefore, Active Case Detection is essential for all areas in the country and the same should be further supported by establishment of Fever Treatment Depots and Voluntary Link Workers. The details of justification for chemotherapeutic approach to malaria at the time of collection of blood smear i.e. presumptive treatment is discussed in Chapter- 3 on chemotherapy which may be referred. In Chapter- 3 the National Drug Policy and how to develop a drug policy for various malariogenic paradigms of a country have been exhaustively discussed.

It is a fact that fortnightly surveillance by domiciliary visits may not be able to detect all malaria cases especially those who had fever episode in between two visits of MPW and at the time of the second visit were symptomless and away from the house. To plug this lacuna in the system of active case detection, the Expert Committee on Malaria - 1995 appointed by the Government of India has suggested that under the Indian Programme, the case detection can be strengthened by establishment of Fever Treatment Depot and Voluntary Link Worker for malaria at the rate of one per 1,000 population or part thereof, if the village population is small and approach is difficult or the village is cut off during the rainy season from rest of the area.

Components of Activity under PCD

This component is to be carried out by voluntary workers drawn from local residents or voluntary agencies operating locally and other health workers like MPW (female), the Supervisors in

their headquarters or 'other Govt. functionaries' i.e. Anganwadi workers, malaria clinics, private practitioners, etc.

Examination of Blood Smears Collected

The blood smears collected by ACD & PCD are to be examined expeditiously. Under the current staffing pattern and system there is a considerable time lag between collection and examination of blood smears due to inadequate facilities.

Decentralization of the Microscopy

The laboratories for malaria microscopy should be decentralized and brought as near to the community as possible.

Organisation Available and its Strengthening

At present the PHC has one malaria microscopist. However the present PHC covers a larger population and wider area. The envisaged plan of PHC system is to provide one PHC for 20,000 population in hilly tribal areas and for 30,000 in other areas when fully functional. These will be adequate to meet the requirement of many areas in the country.

Therefore, pending establishment of new PHC, the likely site for new PHC may be identified and in it the laboratory for malaria microscopy should be established during the preparatory phase of the revised strategy. This is to be further strengthened by additional malaria microscopic centres wherever required.

Each malaria laboratory should have a laboratory attendant who will clean micro-slides, prepare blood smears from fever cases coming to the facility, stain the smears and help in microscopic examination, if work load is high.

Justification

a. This would bring the blood smear examination facility nearer to the community.

b. Time lag between blood smear collection and examination will be reduced.

c. In an area with 20,000 population expected fever rate during peak transmission period can be near about 2.5% of the population per month i.e. about 500 blood smears during peak period which is a reasonable workload for a malaria microscopist and therefore no time lag is envisaged.

d. Correct microscopic identification of parasite will meet the requirement of administering appropriate radical treatment to a malaria case.

Supervision of Malaria Laboratory

The present supervision of PHC malaria laboratories is very deficient. This can be appropriately strengthened by providing one Senior Laboratory Technician over five laboratories for on the spot supervision and cross-check a sample of positive and negative smears.

SECTION - 3
INTERVENTION MEASURES FOR TRANSMISSION CONTROL

INTRODUCTION

In case of malaria, the two important components of disease management are:-

i. Early case diagnosis and prompt treatment

ii. Intervention measures undertaken for transmission control. The vector control is not a synonym for intervention measures undertaken to interrupt transmission. **The basic fact is that it is not always necessary to control vector population for achieving transmission interruption. Methods like insecticidal spray or use of impregnated bednets, in principle, are used to reduce the longevity of the vector or to minimise the man-mosquito contact. Antilarval operations are aimed towards control of vector population.**

To achieve successful malaria control, it is necessary to understand the nature of **malaria problem in a locality, risk of infection, bionomics of vector** and **human behaviour** as well as **environmental conditions** which are some of the prerequisites for planning effective intervention measures for transmission control in a defined area. To plan, implement, monitor and evaluate the impact of a mix of intervention measures on local malaria transmission dynamics, it is necessary to establish parameters necessary to **periodically evaluate the utility of the control measures and their impact on transmission dynamics,** with a view to introduce necessary changes in the control technology. Such evaluations are required to meet the local demands of the operation and to make it more cost-effective.

Before each intervention measure is discussed and its utility in malaria control operations is established, it is necessary to understand the terminologies commonly used in this context.

Integrated Disease Vector Control Measures

The integrated disease vector control measures are a mix of different control measures applied to limit the vector population or to reduce their longevity or measures directed towards reducing the man-mosquito contact and thereby the infection. It is, therefore, evident that under the integrated vector control, the adulticides, larvicides, water management, biological agents and mosquito repellents are used in a judicious manner. Each of the above methods is targeted to a specific area in the chain of malaria transmission where it will produce the maximum effect.

Selective Control Measures

While speaking on selective vector control measures, most of the experts confine themselves to selective use of insecticides for vector control. As stated earlier, the control methods are directed for interruption of transmission and not to control vector population. However, **the basic meaning of selective control is the application at targeted site - specific control activities that are cost-effective. As generally acceptable, it is selective use of insecticide in time and space to produce the maximum effect on vector population i.e. how and when the resting areas of mosquitoes should be sprayed with residual insecticides.**

Control operations currently available for interruption of transmission are:-

- Indoor residual insecticidal spray.
- Space spray with pyrethrum to achieve immediate knockdown.
- Antilarval operations:-

a. Use of larvicides.

b. Use of biocides.

c. Biological methods.

d. Source (breeding site) reduction methods.

- Water management

Modification and filling-up of breeding sites and mosquito proofing of breeding sites.

- Personal protection measures - clothing, mosquito proofing of human dwellings, use of repellents, creams, oils (Neem oil), use of coils, mats and other mosquito repellent devices, use of bednets, impregnated or ordinary, for prevention of man-mosquito contact. The details of personal protection measures including the use of impregnated bednets are discussed in Chapter- 7.

It is generally agreed that malaria endemic areas should receive high priority for implementation of intervention measures for transmission control in the following order:-

i. Areas with foci of drug resistance.

ii. Epidemic areas where high morbidity and mortality are encountered.

iii. Areas where vulnerable group of population, non-immune infants, children and pregnant women are at a higher risk of malaria.

iv. Another attribute of the area may be where the population lives in inadequate housing units surrounded with permanent breeding places.

v. Project areas with tropical aggregation of labour such as construction projects like canals, dams, rail or road and major housing units in urban or industrial areas.

- Areas having drug resistant problem: Those areas, where *P.falciparum* is resistant to commonly used antimalarials in the country like Chloroquine, long acting Sulfa+Pyrimethamine combination or even Mefloquine, require high priority because of the danger of mortality in persons infected with drug resistant strain of *P.falciparum* or danger of precipitation of resistance to second or third line of antimalarials.

- Meso and hyper endemic areas also deserve a place of priority under malaria control programme. In these areas, the vulnerable group of population i.e. infant, children and pregnant women are at very high risk to malaria morbidity and mortality.

Before launching intervention measures for transmission control, it is necessary to collect basic information for planning, implementing and choosing a mix of most suitable transmission intervention measures for the locality. **Usually information required should be collected through special survey by specialists falling under general health services and other sectors which inadvertently contribute to malaria problem in the area. The list of such sectors differs from area to area and from country to country. It is also necessary to collect the information on population structure, its distribution, family size, accommodation and agricultural pattern of the community. The information on socioeconomic aspects of different population sections of the locality is usually beneficial while planning the control operations. Human behaviour of the local community should be investigated and findings considered while selecting the mix of intervention measures. The human behaviour should include sleeping habits, housing, attitude towards malaria, attitude towards accepting a particular intervention measure such as acceptance of antimalarial drug(s) during an acute episode of fever, insecticidal spray, larvicides or use of fish in water bodies as antilarval, etc.** The disease distribution by **age, sex and occupation** provides information on the group of **population at higher risk** of malaria within the same locality. The **distribution** of malaria **over a period of time** will indicate the duration of transmission period over which the transmission control intervention measures have to be applied rigorously. If the transmission control measures are not tailored to cover the transmission period of the area, there will be no dent on malaria incidence in the locality, in spite of application of intervention measures. Thus, huge expenditure incurred on the operation will be rendered infructuous. The other information necessary is in relation to **vector**, its characteristics, **breeding sites, biting habit, biting time and place of man-mosquito contact** which can be easily collected by a trained entomologist and will go a long way towards proper planning of the control operations.

Stratification of Malarious Areas

A lot has been said about stratification of malarious areas and different methods have been suggested by different experts. Somehow the use of word stratification relates to the prevalence of malaria within the locally eco-geographical

system. It is usually not necessary to go into such a detailed stratification of the country for planning malaria control operations.

The intervention measures are directed towards prevention of man - mosquito contact before/after the mosquitoes become infective

Therefore, the stratification of the area should be based on the transmission dynamics in the malaria paradigms, so that frequency and time of man-mosquito contact can be established properly and the intervention measures are directed to prevent man-mosquito contact during this period.

Residual Insecticides

Most of the insecticides having residual effect are sprayed indoors, so that mosquito after having come in contact with an infective person will rest in the house and will pick up sufficient insecticide and its longevity will be reduced so much so that it does not survive to become infective. There are a large number of insecticides which are used as adulticides for indoor spray. These are DDT, BHC, Malathion, different formulations of organophosphorus compounds and synthetic pyrethroids.

DDT

In India, DDT has been in use for malaria control operations since 1946. In the beginning it had a very good impact as a transmission control measure but later vector resistance to this insecticide was recorded in certain parts of the country. The community also became indifferent to the use of insecticides because malaria control was no longer a felt need of the community. Recently there has been a tendency to curb the use of DDT due to its persistence in the environment. It is a fact that if DDT is applied in agriculture, it contaminates water sources, enters the biochain and at each step of the biochain, it gets more concentrated (bio-magnification) till it reaches human beings. In human body, it is stored in the body fat and is excreted in milk. Therefore it reaches the infant right from the time of birth. Since DDT persists for a long time in the community, there has been apprehension that it will produce adverse impact on human metabolism and growth. However, in spite of extensive use of DDT in agriculture, no adverse reaction of DDT on human health has been reported so far. A study group of WHO in their monogram has observed the following :-

Use of DDT in Vector Control

The Study Group considered the current situation regarding the use of DDT for controlling vector-borne diseases, in particular malaria, in the light of two recent publications suggesting an association between DDT and human cancer, a report on the presence of DDT in breast milk, and two general reviews on the subject. Two expert toxicologists were invited to review these papers, including the citations, and to participate in the discussions. After careful review of the documents and intensive discussions, the Study Group concluded that:-

1. The information presented does not provide convincing evidence of adverse effects of DDT exposure as a result of indoor residual spraying as carried out in malaria control activities.

2. There is therefore, at this stage, no justification on toxicological or epidemiological grounds for changing current policy towards indoor spraying of DDT for vector-borne disease control.

3. DDT may therefore be used for vector control, provided that all the following conditions are met:

a. It is used only for indoor spraying.

b. It is effective.

c. The material is manufactured to the specifications issued by WHO.

d. The necessary safety precautions are taken in its use and disposal.

4. In considering whether to use DDT, governments should take into account the following additional factors:-

a. The cost involved in the use of insecticides (DDT or alternatives).

b. The role of insecticides in focal or selective vector control as specified in the Global Malaria Control Strategy.

c. The availability of alternative vector control methods, including alternative insecticides (in view of the availability of alternative insecticides for indoor residual spraying, some of which may compete with DDT in terms of epidemiological impact, public acceptability, logistic suitability and compliance with specifications issued by WHO, DDT no longer merits being considered as the only insecticide of choice).

d. The implications of insecticidal resistance, including possible cross-resistance to some alternative insecticides;

e. The changing public attitude to pesticide use, including public health applications.

5. Given the paucity of data suggesting adverse effects of indoor house spraying, further epidemiological investigation using rigorous scientific protocols is to be encouraged.

6. Further studies should also be carried out to:-

a. Examine the health effects of DDT in breast milk on breast-fed infants, including any resulting behavioural change.

b. Investigate thoroughly any suspected association between the use of DDT in routine malaria control activities and an increased incidence of cancer.

c. Clarify the significance of the reduction in muscarinic receptor density caused by DDT.

About 10 years ago, one of the renowned toxicologists has stated that a person taking daily even one glass of chlorinated water runs the same risk of metabolic disorders or the risk of developing carcinoma, as those who are exposed to DDT. This gives an idea how innocuous is DDT to human health. Unnecessary alarm has been spread by environmentalists. The second aspect which should be given greater emphasis is that the **use of DDT for control of communicable diseases does not expose the environment to the risk of DDT and it does not enter the biochain from the places where it is sprayed for vector control. The situation is entirely different when it is applied in agriculture from where it directly enters the biochain.**

DDT has an added advantage. It is comparatively cheaper than other insecticides and even in those areas where resistance to DDT has been recorded in studies with WHO test kits, the epidemiological impact of good spray operations is seen because of its excito-repellent action.

HCH (BHC)

Benzene hexachloride is used in water wettable formulation for control of malaria. It is also used extensively in agricultural field. Malaria vectors have shown resistance to HCH in almost all areas of India and other South East Asian countries. The resistance in Anopheline vector(s) develops against gamma isomer of HCH, the product which is the only active ingredient of this insecticide. The other two isomers are not so effective as an insecticide and are more toxic. Further HCH has no excito-repellent action as seen with DDT. In areas where vector has developed resistance to HCH, the epidemiological impact is usually not seen even after complete spray coverage. Considering the above points it may be inferred that HCH has outlived its use in control of communicable diseases.

As the vector develops resistance against the active ingredient - the gamma isomer of HCH, there will be no advantage of Lindane in areas where vector is resistant to HCH and a country where vector is resistant to HCH should not waste time and financial resources in conducting trials with Lindane for control of communicable diseases especially malaria.

Organophosphorus Compounds

The organophosphorus compounds have added advantage; there is seldom cross-resistance with these compounds to DDT or HCH.

However, extensive and long term use of any of the organophosphorus compounds such as Malathion results in selecting a resistant strain in the local vector species. The disadvantage of organophosphorus compounds is that unlike their use in agriculture where a farmer uses the organophosphorus compound for crop protection only once or twice a year, the spray squads engaged in spraying residual insecticide in the human dwellings work with these compounds for

periods extending up to 6 or 7 months. This long exposure results in acute toxic symptoms and if not controlled properly may lead to mortality. Therefore, the peripheral staff engaged in spraying of organophosphorus compounds are to be provided with more elaborate protective garments and their blood cholinesterase level is to be checked periodically to assess the toxic impact of the compound. These compounds are also toxic to domestic pets. The quantity of organophosphorus compounds required for spray operations for the same surface area is nearly three times more than that of HCH and six times more than that of DDT. The residual effect of the insecticide is for a shorter period. Under Indian conditions, three rounds of spray with organophosphorus compounds are given as against two rounds of spray with DDT.

Synthetic Pyrethroids

These are new insecticides introduced for control of vector-borne diseases in India. They are less toxic as compared to any other insecticide available for vector control. However, the cost is much higher than the cost of DDT, HCH or organophosphorus compounds. Even there is difference in the cost involved in spraying of a unit area. The difference in the cost of various insecticides and cost of their application vary because the price of insecticide fluctuates due to inflationary pressure in the country or on account of the shortage of insecticide in international market or in case the insecticide is produced in limited quantity due to objection of environmentalists, the cost of manufacturing insecticide goes up. Therefore, it is essential that a sound technical criterion should be adopted for choosing residual insecticide.

The residual insecticide spray usually precipitates resistance in malaria vectors. Although use of residual insecticides during indoor spray for control of communicable diseases does not pose serious environmental hazard, it necessitates a **strict justification for their continuous use. Therefore, its use should be made only in high priority areas for malaria control. Other considerations are frequency of application of indoor spray and the time of application.** These are decided on the basis of duration of residual effect of insecticide and the length of the transmission period in the area.

Once it is decided to carry out indoor residual insecticidal spray, it must be a time bound programme tailored to the need of transmission dynamics of the area. Any disruption or partial spray will result in continued malaria transmission.

The epidemiological impact can be assessed correlating the quality of spray coverage in terms of dosage, coverage of resting places of mosquitoes and the spray schedule in relation to local transmission period. Impact of the insecticidal spray on local transmission will be reflected through annual parasite incidence. The continuation of spray operation over the years should depend on the reduction in parasite incidence and its load in the community and the targets set.

Selective Spray

The WHO study group on vector control measures - 1993 has mentioned that there are situations where in a village a single human dwelling or a group of houses nearer to a breeding site are at a greater risk of malaria. In olden days some of these were known as 'malaria houses'. They have further suggested that during selective control only these houses need to be sprayed. This suggestion seems to be sound but a vector due to excito-repellent action, may in course of time, avoid these houses and seek blood meal in adjacent houses. **Therefore they have suggested that all dwellings within the flight range of the vector should be sprayed to get better results.**

It has been suggested by some authorities that the indoor residual spray can be targeted at selected houses where the risk of transmission is highest. In the Indian context, depending on the flight range of the mosquito and the transmission potential of the area, usually the spray is planned in selected villages or hamlets of the villages if they are within the flight range of the vector mosquito. In some other countries, the house spraying is confined to either the walls or ceiling of the house depending on the resting behaviour of the vector. In practice, it has been found that if there is a partial coverage of the usual resting places of vector in the house, after coming in

contact with the sprayed surface, the vector is excited and it may fly and rest on the unsprayed surface within the same premises. It is, therefore, necessary that all resting places of the mosquitoes in the human dwellings should be sprayed. **Similarly the mixed dwellings should be covered. There is no need to spray cattle sheds.** This will result in minimising the selection pressure on vector population, reduce the consumption of insecticide and also reduce the environmental pollution. This will reduce the cost of spray operations both in terms of the quantity of insecticide and cost of its application and thereby reduce the cost of malaria control operations in the area. Wherever the vector is endophagic and endophilic, the impact of residual insecticidal spray is maximum. Even species like *An.minimus* and *An.fluviatilis*, which rest indoors for 6 to 8 hours for partial digestion of blood meal, migrate from the human dwellings after partial digestion of blood and rest outside. Only in case of vectors which are endophagic and exophilic and do not rest indoors after feeding, the effect of insecticidal spray becomes infructuous.

Under the Indian programme the selective insecticidal spray operations have been suggested by the Expert Committee on Malaria - 1995. The Expert Committee has suggested that a Subcentre should be a unit for selection of areas for implementation of intervention measures for transmission control. In view of the global policy on malaria control, present thinking is that the unit for selection of spray operations should be a village. **The criterion applicable for selection of high risk villages has been given by the Expert Committee. If the village has got more than one hamlet and if the hamlet is beyond the flight range of the vector mosquito, it should be considered as a separate entity for malaria control.** The criterion for selection of an area to be sprayed should be based on the SPR recorded in the village during the last three years. Having tabulated the villages on the basis of SPR, the areas should be categorised on the criteria given by the Expert Committee-1995 which are given below:-

1. Recorded deaths due to malaria (on clinical diagnosis or microscopic confirmation of *P.falciparum* infection) during the transmission period with evidence of locally acquired infection in an endemic area, during any of the last three years

2. The Slide Positivity Rate (SPR) index is to be used for the identification of the areas as follows:-

    a. Doubling of SPR during the last three years provided the SPR in second or third year reaches 4% or more. or

    b. Where SPR does not show the doubling trend as above but the average SPR of the last three years is 5% or more.

    P.falciparum proportion is 30% or more provided the SPR is 3% or more during any of the preceding three years.

3. An area having a focus of Chloroquine resistant *P.falciparum* (A Chloroquine resistant PHC will be characterised by detection of more than 25% of R II and R III level cases in a minimum sample of 30 cases), as per WHO recommendation.

4. Tropical aggregation of labour in project areas.

5. New settlements in endemic/receptive and vulnerable areas.

The selective application of residual insecticide for control of malaria transmission in the area can be through use of impregnated bednets. The advantages and disadvantages of impregnated bednets are discussed separately. Here it will suffice to say that impregnated bednets will have impact on local transmission in areas which are under the influence of a vector which is endophagic, endophilic/exophilic, but is a late biter. The maximum impact of bednets will be obtained in areas where the biting starts late in the evening, say 9 p.m. to 10 p.m. and peaks after midnight say 1 a.m. to 3 a.m. In areas where the biting time of the vector species starts at dusk and peaks before midnight, the impact of bednets on transmission will be minimal.

Selection of Insecticide

Many factors are considered while selecting insecticide for indoor residual spraying. These are:-

1. Residual Effectiveness

a. The duration of residual action - longer the duration of residual action of insecticide, lesser the number of spray rounds required to cover transmission period.

b. The local vector should be susceptible to the insecticide. In some cases, the WHO test kits may show that there is a resistance problem with the local vector but with insecticide like DDT, the epidemiological impact should be evaluated before changing over to other insecticide.

2. Safety

The acute and chronic toxicity of insecticide, its persistence in environment or accumulation of residue in human body with proven adverse effects of such accumulation should be considered before selection of insecticide.

3. Cost

The cost of different insecticides is very important and it should be taken into consideration. Such calculation of the cost would require the total quantity of insecticide per unit of sprayable surface area to be covered and number of rounds to cover the entire period of transmission (i.e. for two or three rounds). This should include operational cost of spray.

4. Other Considerations

Other important factors which affect the acceptability of insecticide are its odour, visibility of spray deposits and action against domestic animals.

5. Availability

The important consideration which should be taken into account by the planners at national level is availability of insecticide on long term basis through local manufacturers to cover the target areas. In case the insecticide is imported, its supply should be ensured by a bilateral agreement for a specified period of time, keeping in view the diplomatic relations, production capacity of the donor country and foreign exchange availability for purchase of insecticide over the entire period. In the past, most of the programmes in South East Asia suffered because donor countries all of a sudden decided in 1960s to change the mode of supply of insecticide. Negotiations of the revised contract took much longer time than envisaged and in almost all South East Asian countries, the spray operations were disrupted for a varying number of years resulting in focal outbreaks and resurgence of malaria.

The formulations and dosages of different adulticides for indoor residual spray and space spray are given in Table- 6.4. and Table- 6.5. respectively.

Table- 6.4 :
INSECTICIDAL FORMULATIONS AND THEIR DOSAGES FOR INDOOR RESIDUAL SPRAY

S. No.	Name of the Insecticide	Preparation of suspension in water	Dosage per sq. metre of active ingredient	Residual effect in weeks	No. of spray rounds per annum	Requirement per million Population		Area to be covered by 10 lit of suspension to get correct dosage
						per round	per annum	
1	2	3	4	5	6	7	8	9
1.	DDT 50% wp	1 kg / 10 Lit	1 gm	10 - 12	2	75 MT	150 MT	500 sq. m
2.	BHC 50 % wp	1.5 kg / 10 Lit	200 mg (γ isomer)	6 - 8	3	112 MT	336 MT	500 sq. m
3.	Malathion 25% wp	2 kg / 10 Lit	2 gm	6 - 8	3	300 MT	900 MT	* 250 sq. m
4.	Deltamethrin 2.5%wp (K-Othrine)	400 gm / 10 Lit	20 mg	10 - 12	2	30 MT	60 MT	500 sq.m
5.	Cyfluthrin 10% wp (Solfac)	125 gm / 10 Lit	25 mg	10 - 12	2	9.38 MT	18.75 MT	500 sq. m
6.	Lambdacyhalothrin 10% wp (ICON)	125 gm / 10 Lit	25 mg	10 - 12	2	9.38 MT	18.75 MT	500 sq. m
7.	Fenitrothion 40% wp	1.25 kg. / 10 Lit	1 gm	6 - 8	3	93.75 MT	281.25 MT	500 sq.m
8.	Pirimiphos-methyl 25% wp	2 kg / 10 Lit	2 gm	6 - 8	3	300 MT	900 MT	* 250 sq.m

*To be sprayed in two coats i.e. after completing the first coat in all the rooms, the second coat may be given so that the required dose of 2 gm/sq. m. is obtained.

Table- 6.5 :
INSECTICIDAL FORMULATIONS AND THEIR DOSAGES FOR SPACE SPRAY

S. No.	Name of Insecticide	Commercial formulation	Preparation of formulation	Equipment used	Remarks
1.	Pyrethrum extract	2.0% Extract	1 : 19 i.e. 1 part of 2% pyrethrum extract in 19 parts of Kerosene (v/v)	Flit pump or hand operated fogging (micro discharge) machine	Used for indoor space spray
2.	Malathion	Technical Malathion	5 parts of Tech. Malathion in 95 parts of Diesel oil (v/v)	Vehicle mounted thermal fogging machine. Speed of vehicle 6 km/hour or as recomm-ended by machine manufacturers	Outdoor thermal fogging. Watch for wind conditions before fogging.

N. B. The requirement of 2% pyrethrum extract may be worked out on the basis of malaria positive cases in the past. One litre of 2% Pyrethrum after dilution with 19 litres of kerosene will be sufficient to spray about 400 households, each household having 100 cubic metres indoor space (i.e. 8 malaria cases @ 50 households in and around every malaria positive household)

Quality Control :

The insecticides and larvicides procured by the Directorate of NMEP are subjected to quality control certification through recognised laboratories before despatching the material to the States. The samples collected from the field and sent to Directorate of NMEP are also subjected to quality testing at the recognised laboratories. There should not be any laxity in this regard. When there is slightest indication about the quality, the users should get the samples re-tested.

The insecticides/larvicides purchased by the State Governments should also be subjected to strict quality control, not only at the time of procurement but also throughout the shelf life period. They should get the quality control certificate from recognised laboratories.

ANTILARVAL OPERATIONS WITH CHEMICAL LARVICIDES

The antilarval operations are based on use of chemical larvicides wherever required in conjunction with minor engineering methods and larvivorous fish. They are easy to implement in urban areas where mosquito breeding sites per unit population are less and treatment of breeding sites is also economical. In those areas where other methods of control are not readily acceptable to the community, larviciding is the only alternative method.

The readily available and commonly utilised chemical larvicides are:-

i. Mosquito larvicidal oil (MLO)

ii. Temephos

iii. Fenthion

iv. Pyrethrum based emulsifiable oil (Pyrosene)

v. Paris green

Mosquito Larvicidal Oil

Usual problem with mosquito larvicidal oil is the spreading quality. There have been instances where the spreading quality was not uniform in different batches. Therefore, the authorities prefer to use other chemical larvicides. However, the advantage of MLO is that it can be easily supervised as the MLO film along water edges is easily recognised. Its disadvantage is that it can be applied only in water bodies generally not used by man or animal. It burns the vegetation along the shoreline of the water body. Another drawback is that the bulk of oil required per unit population/ water body area is 2000 to 4000 times more as compared to fenthion and temephos respectively.

Other Chemical Larvicides

Both **tempephos and fenthion** are easily available and together can control mosquito breeding in all types of water collections i.e. potable or polluted.

The **Pyrethrum based emulsifiable oil** is not being used under NMEP and its quality and emulsification are difficult to maintain and quantity required per unit area is 400 and 800 times more than fenthion and temephos respectively.

Paris green although very old chemical larvicide is still one of the chemicals of choice for rural and peri-urban areas. In the dosage used it is not toxic to animals, birds or fish, etc. but on account of fear of environmental pollution its utility is at present controversial and the quantity required per unit area is 10 to 20 times more as compared to fenthion and tempephos respectively.

Some of the larvicides can be used in rural situations but extensively in urban areas. These are used in situations where it is not possible to use alternative bio-environmental methods.

Limitation of Antilarval Measures

The use of antilarval operations has got certain limitations. By nature, the breeding sites of vector mosquitoes vary from season to season or even from day to day depending on the type and nature of the breeding places. The permanent breeding places i.e. man made water containers or water storage tanks can be easily identified, enumerated and treated regularly to prevent mosquito breeding. However the major vector of malaria in India - *An.culicifacies* and other important vectors breed in natural water collections such as ground water, canals, rivers, streams, seepage water channels, etc. These fluctuate depending on the amount of rainfall, number of rainy days, soil characteristics and natural contours of the terrain. Most of the ground water collections are of temporary nature and present during the rainy season, just like small depressions in the ground, hoof marks in irrigation channels, etc. It is very difficult to enumerate them and mark their precise location in the map drawn for antilarval operations. The other disadvantage of antilarval operations is that they have to be carried out at weekly intervals regularly. While indoor residual spray operations are usually

carried out twice or thrice a year, the community can be motivated to accept these operations and cooperate with the spray squads, whereas the antilarval operations are to be carried out 52 times a year in each of the domestic, intradomestic and peridomestic breeding places. It is usually very difficult to get the cooperation of the community for accepting weekly application of antilarval operations in intra-domestic breeding places.

The antilarval agent (chemical or biological) should be carefully chosen keeping in view the nature of breeding site.

Most of the chemical larvicides produce contamination of water and to that extent they are inhospitable to environment. Their target is specific action against larval and pupal stages of mosquitoes and usually do not adversely affect the other biological species present in the water.

Some of the chemical larvicides can be used in potable water and in the dosage prescribed do not have adverse impact on the human or animal health. However, these do require further carefully controlled studies. Other chemical larvicides like fenthion which is used in polluted water, does produce good impact on mosquito breeding but is likely to pollute the water bodies in the environment. The biocides like *Bacillus sphaericus* and *Bacillus thuringiensis* are more bio-environmental friendly than chemical larvicides. The efficacy of formulations of these biocides sometimes differs from formulation to formulation and even in the same formulation from batch to batch. Although supposed to propagate in the water body, frequent applications are still required to maintain adequate antilarval action.

Apart from the above, the country should choose larvicides or biocides carefully keeping in mind the breeding habitats of local vectors and availability of good quality formulations. They should also ensure regular flow of stocks to prevent disruption of antilarval operations. If the antilarval operations are disrupted, the mosquito densities will increase and transmission will be resumed in the area. The application of antilarval operations is more painstaking and all breeding places should be covered regularly. Operationally it is difficult to organise and still more difficult to supervise. In urban situations larviciding is the method of choice for malaria control while in peri-urban and rural areas, these can be used in the specific areas. It is necessary that the Government should lay down specifications for quality control for use of larvicides and this should be strictly adhered to.

Table- 6.6 gives the larvicide formulations and their dosages while Table- 6.7 gives the choice of Bioenvironmental Control methods which can be implemented in potential breeding places for the control of mosquitoes breeding.

Table- 6.6 :

LARVICIDAL FORMULATIONS AND THEIR DOSAGES

S. No.	Name of Larvicide	Commercial formulation	Preparation of ready to spray formulation	Dosage per			Frequency of application	Equipment required	Remarks
				One sq. metre	50 Linear Metres	One Hectare			
1	2	3	4	5	6	7	8	9	10
1.	M L O	100% petroleum product	As it is	20 c.c.	1 Litre	200 Lit.	Weekly	Knapsack/ Hand compression sprayer	To be applied along the shore of water body
2.	Paris green	Powder	1 kg added to 99 kg of inert dust	10 gm	500 gm	100 Kg.	-do-	Hand or hand-operated duster	- do- Can be applied to water consumed by Cattle, etc.
3.	Temephos * (Abate)	50% E.C.	2.5 c.c. in 10 litres of potable water	20 c.c.	1 Litre	200 Lit.	-do-	Hand compression/Knapsack sprayer	Can be applied in all water bodies
4.	Fenthion* (Baytex)	100% E.C.	5 c.c, in 10 litres of potable water	-do-	-do-	-do-	-do-	-do-	Not applied in drinking water sources like wells, etc.
5.	*B. sphaericus*	Powder	500 gm in 10 litres of potable water (5% suspension)	-do-	-do-	-do-	Three Weekly	-do-	Not used in potable water collections
6.	*B. thuringiensis*	Powder	250 gm in 10 litres of potable water (2.5% suspension)	-do-	-do-	-do-	Two Weekly	-do-	-do-
7.	Aviation Gasoline Lead Free (AGLF)	Liquid	As it is	90 cc	4.5 Lit.	900 Lit.	Weekly	Sprinkling with the container	To use in potable/ drinking water bodies in the evening

* The dose of temephos or fenthion may be doubled or tripled in case of water bodies having more than 50 cm depth.

Table- 6.7 :

CHOICE OF BIO-ENVIRONMENTAL METHODS WHICH CAN BE IMPLEMENTED IN POTENTIAL BREEDING PLACES TO CONTROL MOSQUITO BREEDING

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
		Short term repetitive			Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
1. Wells i. Sweet water a. Shallow wells less than 2 m deep or those which overflow in rainy season	Any size	P	Larvivorous Fishes, 50 female fishes per sq metre of surface area	EPS beads	Hermetically Seal the well and install a hand pump	Put an iron grill with wire gauze cover ; mesh size 1.2 to 1.3 mm ; aperture diametre with a trap door for drawing water. The trap door to be closed after use, and at sunset.	*An.stephensi* *An. Culicifacies* and Culex mosquitoes breed, if not sealed. These should be covered at sunset and when not in use. if larvivorous fishes are not present	Malaria Organization (or) Gram Panchayat volunteers, material to be supplied by Malaria department	Individual or Gram Panchayat or the organization to which it belongs, if it is a common use well
b. Deep-more than 2 m deep ; do not over flow	Any size		-Do-	-Do-	-Do-	-Do-	-Do-	-Do-	-Do-
ii. Unused wells	Any size	P	EPS beads	Nil	Close or hermetically seal the well	Nil	Such wells are a source of most profuse mosquito breeding both *Culex* and *Anopheles*	Malaria department	Individual, Gram Panchayat or organization to which it belongs. Malaria department will coordinate
iii. Irrigation Agricultural wells	Any size	P	EPS beads if fitted with pumpset	Nil	Hermetically seal the well and install pumping set	Nil	It breeds mosquitoes, if not used often	Malaria department	a) Individual farmer, he may try to get subsidy if available

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
		Short term repetitive			Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
									b)Organisation concerned
2. Overhead tanks a. Cement b. Steel c. Plastic	Any size	P	Larvi- vorous Fishes	EPS beads	make the tank mosquito proof by closing the top of the tank and providing standard cover on the man hole, vent pipe out- let to be covered with wire gauze mesh size 1.2 to 1.3 mm aperture diameter.	Nil	Mosquitoes specially *An.stephensi* and *Aedes* vectors of malaria and dengue respectively breed profusely in such tanks, if they remain open. Breeding is intense in cement tanks, less in steel and plastic tanks	Malaria department	Individual, Local bodies can make legislation to penalise owners of tanks which are not mosquito proof
3. Rain water pools stagnant for									
a. < 1 month but > 15 days	depth less than 10 cm	T	Drain by Temporary Channeli- sation		Nil	Nil	As the water depth is shallow and duration short either only transient or no breeding will take place	Nil	Nil
b. > 1 month to < 6 months	depth more than 10 cm	T	fishes	Larvi- vorous shallow areas	a) Land filling and dressing of	all types of	Seasonal breeding of or local	Malaria department dan, The finge-	Local bodies through Shram

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
c. > 6 months	Any size	P	Larvivorous fishes	Nil	b) Dressing of margins of deep pools and their use for fish farming Also introduce larvivorous fishes		mosquitoes depending on water characteristic. Shallow land depression is best treated by land dressing. Deep water collection should be used for income generating schemes	bodies	rling of edible fish can be had from Fisheries Department and Larvivorous Fishes from malaria organization Technical guidance from malaria organization
4. Pokhar village ponds	Small deep	P	Larvivorous Fish. Cleaning of margins		a) if very small and filling will not disturb natural drainage fill up	If big, dress margins. Use for fish culture along with larvivorous fish	The medium or big ponds can be used for income generating schemes	Malaria department or local bodies	Gram panchayat or any other local body. if individually owned. Technical guidance malaria organisation and Fisheries Department of local bodies, Gram Panchayat through Shram Dan, PWD or other agricultural societies can subsidise or undertake the work of permanent nature.
5. a) Hoof marks or wheel ruts	Small, numerous	T	Nil	Nil	Road dressing	Paving of roads	Treatment required only if water collection is big enough and stands for more than 10-15 days.		
b) Hoof marks on river margins	-Do-	T	Weekly flushing	Nil	Underground drainage at margins	Nil			
6. Tyres, empty tins, water bottles and other such containers	Small	T	empty every week	Nil	Store in a place where rain water cannot accumulate in them	Puncture the base or destroy if not required	In such small articles mosquitoes breed profusely during rains, if water collect-	Individual, house or shop owner	Individual, house or shop owner. Health education, technical guidance by Malaria organisation.

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
7. Underground water tanks	Any	P	Larvivorous fishes	Nil	Hermetically seal the vent of the man hole should be of standard specifications	Nil	ion occurs These breed profusely inlet is open	Malaria department	Individual with technical guidance from malaria department.
8. Out/indoor ground open tanks or troughs	Any	P	empty weekly Ensure that it is dry for at least 1/2 to 1 hour	Larvivorous fishes	Iron grill with wire gauze cover mesh size 1.2 to 1.3 mm aperture diameter if possible.	Nil	Avoid Seepage and water pooling around these by making pucca platform	Malaria department	Individual with technical help from malaria department.
9. Earthen pots, small cisterns barrels, drums	Small	T/P	empty weekly	cover with a tight fitting lid			such collections breed mosquito and add to mosquito nuisance in the house. Thus individual should take care of these sites.	Individual Health education and technical guidance by malaria organisation	
10. Road side water collection									
a) Borrow pits	Any	T/P	Larvivorous fishes	Connect a number of borrow pits by making a channel along natural grad-	when planning road lay out,borrow pits to be planned properly and	usually badly constructed borrow pits and badly planned roads without ade-	Malaria department	Local bodies, Malaria department to to motivate and co-ordinate with PWD for undertaking remedial measures, primary responsibility	
b)natural depression	Any	T/P	Larvivorous						

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
or obstruction to water flow			fishes	ient, drain collected water in one big depression/borrow pit and dispose off through a culvert or pumping in a water course.	roads should not obstruct natural drainage	quate no. of culverts create this problem		PWD.	
11. Canals									
a) In canals, bed pools, stagnant water pockets along embankment margins	Any	P	a) The canal bed to be dressed periodically specially in lean season to avoid pooling b) dress the margins periodically	Nil	Flushing every week,if possible	Lining of canal with brick, stone or cement mortar or provide a baselining of polythene sheets to avoid water seepage For water collection in borrow pits along canal embankment similar action as in case of road borrow pits	If canals are not lined properly,20 to 30% water is wasted by percolation and seepage. The water collection on both sides of embankment may occur due to breach, poor maintenance and illegal drawing of water from canal Fishes will not be effective if extensive grass or vegetation is present in Seepage collection in borrow pits,such a water body can	Malaria department	Local bodies, Malaria department to co-ordinate with irrigation department. Primary responsibility irrigation department.

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
							be collected in a small area and then dis-charged either in a natural water course or canal system		
b. Seepage from canals		T/P	Biocides, if possible	Larvi-vorous fishes, if possible	-do-	-do-	-do-	-do-	-do-
12. Natural water course									
a)Streams	Any	T/P	Larvi-vorous fishes	Nil	a) Putting up embankments b) stream and river bed dr-essing to avoid pooling c) Channelizing d) In small st-reams periodic flushing by making temporary small device for holding water e) In small streams use fishes	Nil	Usually there is profuse breeding during lean rainy season as a consequence of pool in river or stream beds during rains at the time of high flow or flooding, breeding in the water course is not found	Malaria department	Flood control & natural water re-source development department. Coordination by local bodies & malaria organization
b)Natural depression or obstruc-tion rain water flow.	Any	T/P	Larvi-vorous fishes	Biocide					
c) River side Seepage	Any	T/P	(deal as canal seepage)						

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
13. Marshy land	Any	P	if suitable, use Larvivorous fishes	Nil	Vertical or underground sub soil drainage	Social forestry by Planting fast growing	These sites breed extensively many species of mosquitoes and many diseases are present in their vicinity. This type of land should get due priority while implementing mosquito control measures.	Malaria department	Local bodies, rural development, forest, irrigation, horticuture departments, coodination by malaria organisation
14.Stone quarries	Any	T/P	Larvivorous fishes	EPS beads	drainage	if very small, fill up	The suitable drainage technique for implementing	Malaria department	Local bodies by Shram Dan, contractors through legislation.
15 Brick kilns	Any	T/P	Larvi vorous fishes	-	Drainage	Nil	Vertical,underground or open channel drainage in a natural water course to be adopted	Malaria department Technical guidance, health education by malaria department	Local bodies by Shram Dan, contractors through legislation.
16.Drains a) Open drains b) Gutters	Small	P	weekly cleaning	-	a) provide adequate gradient. b) the bottom should be cement or brick or stone lined at least up to lean period	install underground drainage system	such sites breed nuisance mosquitoes mainly *Culex*.	local bodies	local bodies, PWD if responsible

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
					flow c)provide cunette in big drains		These should not be allowed to be obstructed by solid waste, a proper gradient with 2 feet/sec flow will avoid breeding	Health education by Malaria organisation	
17.Tree holes	Any	P/T	-	-	filling	-	usually tree holes are not of major importance except for villages in dense forest. These may breed malaria vectors also	Malaria department Health education by malaria organisation	local body volunteers, Forest Department
18.Others (Like water for curing roofs & floors) temporary water tanks, at construction site,water collection in lift pits, culverts on highways, roads, etc.)	Any	P/T	any one of the temporary methods as indicated above, if found suitable for the type of water body should be adopted	-	-	- found breed- permanently	such water bodies, if ing mosquitoes, should be dealt temporarily or on their own merit	- deptt., co-ordi	local bodies or concerned nation, technical guidance,health education by Malaria organisation

Mosquito breeding places		Bio-environmental methods for larval control					Remarks	Agency who can take action to implement bio-environmental measures	
			Short term repetitive		Permanent				
Type	Size	Temporary or Permanent (T) or (P)	1st choice	2nd choice	1st choice	2nd choice		Temporary (T)	Permanent (P)
					flow c)provide cunette in big drains		These should not be allowed to be obstructed by solid waste, a proper gradient with 2 feet/sec flow will avoid breeding	Health education by Malaria organisation	
17.Tree holes	Any	P/T	-	-	filling	-	usually tree holes are not of major importance except for villages in dense forest. These may breed malaria vectors also	Malaria department Health education by malaria organisation	local body, volunteers, Forest Department
18.Others (Like water for curing roofs & floors) temporary water tanks, at construction site,water collection in lift pits, culverts on highways, roads, etc.)	Any	P/T	any one of the temporary methods as indicated above, if found suitable for the type of water body should be adopted	-	-	- found breed- permanently	such water bodies, if ing mosquitoes should be dealt temporarily or on their own merit	- deptt., co-ordi	local bodies or concerned nation, technical guidance,health education by Malaria organisation

BIOLOGICAL CONTROL : LARVIVOROUS FISHES

Larvivorous fishes are effective biological control agents and most commonly used for mosquito breeding which should be considered as one of the main planks of the bioenvironmental control strategy.

Use of Larvivorous Fishes in India

Historically the larvivorous fishes have been used for larval control since early part of this century.

It was in the first decade that local fishes were used for control of mosquito breeding by a large number of workers in almost all geographical regions of India such as erstwhile Bombay province, West Bengal, Uttar Pradesh, Punjab, Delhi and many other parts. The food requirements, most suitable habitats and breeding habits of a large number of local fishes were studied with a view to identify the most efficient species suited to local conditions.

Characteristics of a Good Larvivorous Fish

Most of the small fishes eat mosquito larvae but all of them are not efficient. Therefore while selecting a fish for use as a biological control agent, the requirements for an efficient larvivorous fish as postulated by Covell in 1927 and published in bulletin 'Anti-Mosquito Measures' should be kept in mind. These are :

1. Must be small enough to negotiate in shallow water.
2. Must be hardy to survive in both deep and shallow water bodies.
3. Must be able to breed freely in small water bodies or confined water.
4. Must be able to withstand transportation and handling.
5. Must be difficult to catch.
6. Must be absolutely worthless and insignificant as human food.
7. Must be surface feeder and carnivorous.

The physical characteristics that make certain fishes suitable for mosquito control are their flattened heads which enable them to cruise closely beneath the surface of the water; their protrusible mouths which are set forward and are oriented upwards; their small size which enables them to inhabit shallow mosquito-infested waters and penetrate weed infested areas; their high fecundity; and finally, their voracious appetite for live prey, especially insect larvae.

Indian Surface Feeders

Details in regard to larvivorous capacity and other requirements of habitat, etc. have been studied in respect of a large number of local fishes. While a lot of information on their larvivorous capacity and efficiency has been generated, only fragmentary records are available in respect of their bionomics.

The list below gives names of fishes and areas where their larvivorous activity was first studied and reported.

Centops nobiles -	Eastern India
Macropodus cupaus -	Malabar & Coromandal, Bombay, Kerala
Trichogaster -	Delhi.
Ophicephalus punctus -	Delhi
Nuria danrica -	Delhi, W. Bengal
Barbus phutired-	Delhi, W. Bengal
Panchax panchax -	Madras, Bombay, Calcutta
Therapon -	Brackish water habitats
Polycanthus -	Brackish water habitats
Anabas testidinius-	Bombay, Calcutta
Badies badis -	Calcutta
Lebias dispar -	Sindh, Kachchh
Ambassis nama -	W. Bengal
Colisa fasiata -	W. Bengal

Notopterus notopterus -	W. Bengal
Rosbora daniconisus -	W. Bengal
Laubucca atpar -	W. Bengal
Barbus ticto -	Uttar Pradesh, Delhi, Western India, Pakistan.
Ambasis ranga -	Uttar Pradesh, Delhi, Western India, Pakistan.
Colisa -	Uttar Pradesh, Delhi, Western India, Pakistan

Some of the other Indian fishes which prey upon mosquito larvae are:-

Chela laubucca , Chela untrahi, Chela argentea, Salmostoma dacaila Salmostoma phulo, Barilius bendelisis, Danio aequippinatus, Danio (Branchidanio) rerio, Esomus danricus, Amdlypharyngodon mola, Aspidoparia morar, Crossocheilus latius, Puntius phuntino, Puntius sophore (Syn P.stigma), Puntius ticto, Carassius auratus, Oryzias melastigma, Aplocheilus panchax, Aplocheilus lineolatus, Horaichtnys setnai, Chanda nama, Chanda ranga, Etroplus suratensis, Etroplus maculatus and Tilapia mossambica.

Information on Bionomics

The habitat, dispersal, distribution, etc. of these fishes are documented. However, most controversial aspect is their fecundity and breeding period. Most of the fishes breed at least twice a year and some of them at quarterly, bimonthly or even at monthly intervals.

Importance of Density of Fishes in Larval Habitats

With so many fishes available for mosquito control, it is logical to ask why under natural conditions they are not able to keep in check the mosquito population in the area of their distribution. One reason, of course, is that they are not evenly distributed. This is so, as fishes, more often than not, are slow in multiplying and take long time to attain densities required for mosquito control.

After initial interest, the malariologists slowed down further research on fishes as chemical control agents (insecticides) became readily available. During the past four decades the fast-acting insecticides could be quickly applied over large and varied areas in a uniform manner and attain excellent control of mosquitoes. Fishes, on the other hand, are seldom readily obtainable and at times difficult to maintain in large numbers, restricted to certain habitats, and do not kill mosquito larvae instantaneously.

However, now this attitude is changing, as insecticides have become more costly and produce resistant mosquito strains. There is also an increasing public concern about environmental pollution. Certain pesticides persist in the environment where they are biologically concentrated in fishes and other animals which are used as human food.

Among the larvivorous fishes studied so far, the following fishes are most widely and extensively used in India:-

i. *Gambusia affinis*

Habitat -

It is a very hardy fish and can survive in all types of water bodies but does not tolerate very high organic pollution. The optimum temperature is 24^0 C to 34^0 C but can survive even at freezing temperatures. The most suitable pH of water is between 6.5 and 9.9.

Size and Longevity -

The maximum size attained by a male is 4.5 cm and by a female is 5.2 cm to 6.8 cm. Its life span is approximately 4 ± 1 years.

Breeding Habit -

The female matures in about 3 to 6 months and by this time it attains a size of about 3 cm. Each ovary contains approximately 120 eggs. Young ones are released in a brood of 25-30 at a time. The young females have two gestations per season. The older group may have one to six generations per season. A season lasts over a period of 30 days. A full grown fish may produce up to 300 offsprings. It is estimated that a single female produces between 900 and 1200 offsprings during its life span.

Breeding Season -

Reported to breed throughout the year at monthly interval after maturity, specially in tropical countries. However the season and frequency of breeding differs from one climatic zone to another. In temperate climate it lasts from May to September and in warmer climate from April to November.

Larvivorous Efficiency -

It is a highly efficient larvivorous fish.

i. A single full grown fish eats about 100 to 300 mosquito larvae per day.

ii. It is a surface feeder.

iii. It negotiates to the margins of the water container, pond or other ground water collections. But if there is dense vegetation at the margins of the water body, it becomes difficult for the fish to negotiate and eat larvae.

Advantages -

i. It is small and not edible

ii. It is a hardy fish and tolerates salinity

iii. It can withstand transportation and does not require specialized equipment or container.

iv. It survives in new places (water bodies) and multiplies easily. After release when it becomes well established in a water body, the fish can survive in good numbers for years and does not require constant care.

Disadvantages -

i. Highly carnivorous, eats the eggs of almost all fishes in the water body.

ii. Eats away young ones of any fish which are very small. However it does not kill the fingerlings of edible fishes if they are big enough and thus it can coexist with them.

iii. In case of scarcity of food they prey on their young ones and thus the fish population is self limiting.

iv. The fish is preyed upon by big carnivorous fishes and does not get established in ponds where these predators are present.

v. It may fail to give results if the habitat is **i.** cold, **ii.** too heavily infested with plants, **iii.** too extensive or **iv.** too temporary to allow the fishes to achieve sufficient densities required for effective control.

ii. *Poecilia reticulata* (GUPPY)

(Formerly *Lebistes reticulata*)

This is an exotic fish introduced in 1910. It is now widely distributed in India and is considered to be one of the important larvivorous fishes for use in field operations as a biological control agent.

Habitat -

It is a very hardy fish and survives in all types of water bodies. It tolerates high degree of water pollution with organic matter than Gambusia. The optimum temperature range is from 24^0 C to 34^0 C. It can survive in water with pH ranging from 6.5 to 9.0

Size and Longevity -

The male is 3 cm long, whereas the female is up to 6 cm in length. This fish is generally slightly smaller than *Gambusia affinis*. The Guppy lives for 4 ± 1 years.

Breeding Habitat -

The male when matures is 1.8 cm long, the female when matures is 2.5 cm long. The fish takes about 90 days to mature. Each ovary has 100 to 160 eggs. The female gives birth to young ones in a brood of 5 to 7 at a time. About 50 to 200 young ones are released by the female every four weeks.

Breeding Season -

Reported to breed throughout the year at about four weeks interval after maturity. However breeding season will depend on climatic conditions. In tropics it may be from April to November.

Larvivorous Efficiency -

i. A single fish eats about 80 to 100 mosquito larvae in 24 hours. Therefore it is comparatively less efficient than *Gambusia affinis*.

ii. It is a surface feeder.

iii. Negotiates margins of ponds more easily.

iv. It is highly carnivorous and parents or older brood may eat up their own young ones. Therefore, a fair amount of weeds are required in the water so that young ones can hide and survive.

Advantages -

i. It is a hardy fish, tolerates handling and transportation very well.

ii. Does not require specialized equipment for transportation.

iii. Survives and reproduces when introduced into new water bodies. Once well established, it can be found in the habitat even after many years.

Disadvantages -

i. Highly carnivorous, eats even its own young ones.

ii. It is preyed upon by big carnivorous fishes although it can coexist with herbivorous fishes.

iii. ***Danio rerio***

This belongs to carp family. It is a local fish and many other subfamilies of *Danio* are distributed almost all over India. It is a strong swimmer and it can live in slow moving streams.

Habitat -

The fish is found both in stagnant and flowing water. As a powerful swimmer it can negotiate against the water current. It survives in all types of water collections but is sensitive to pH and temperature changes. Optimum water temperature is between 22^0 C and 28^0 C. It is most abundant in South India. Another species *Danio alboleneata* lives in tanks and foothill streams.

Size and Longevity -

4.5 cm to 5 cm, male and female of equal length, lives for about 3 ± 1 years.

Breeding Habit -

Although no firm evidence is available, it spawns at least twice a year and young ones hatch within 24 to 48 hours.

Breeding Season -

Not much is known but probably breeds during March/September or November depending on suitable climate.

Larvivorous Efficiency -

It is carnivorous fish and mostly feeds on insects on water surface. As regards its preference to mosquito larvae the controlled studies are required to assess the impact.

Advantages -

As it can survive both in stagnant and flowing water bodies, it may prove to be more effective and advantageous in foothill areas as a larvivorous fish.

Disadvantages -

Although it can be cultured and mother stocks can be maintained in natural or specially constructed hatcheries, it shares a big disadvantage as found in case of other indigenous larvivorous fishes i.e. high mortality during handling, transportation and new habitats where released and it does not establish easily in new ecosystems with different climatic conditions and water bodies.

Use of Larvivorous Fishes by MRC

A few other indigenous fishes such as *Danio (Brachydanio) rerio, Aplocheilus panchax, Rasbora daniconius, Barillius banila, Punctius spp; Colisa fasciatao, Esomus danricus, A. mola, Chela bacila, Puntius stigma, Puntius sophore, Puntius ticto, Chanda nama and Chanda ranga* were studied for their larvivorous capacity by the field stations of the Malaria Research Centre. Some of these are being used in the field for biological control in rural and urban areas. All these fishes can be cultured in local water bodies or even in hatcheries constructed for the purpose. They do multiply and sufficient stocks can be maintained but the greatest disadvantage is that these are comparatively delicate and often fail to adopt to new environment. They are specially susceptible to changes in water characteristics. Further they register very high mortalities during handling and transportation.

Annual Fishes

The annual fishes require alternately flooded and dry habitats to propagate. This fact has been known in South America since 1881 and in Africa since shortly before the Second World War. Until recently knowledge on these was still fragmentary. In recent field trials they were considered largely successful as larvivorous agents except that in some areas the local people began using the fish as food until too few were left to maintain mosquito control. The highly specialized features of annual fishes are: **i.** survive only for one year, **ii.** spawn once during their life time, **iii.** lay 6 to 7 thousand eggs in the mud at the bottom of the habitat, **iv.** the eggs have an incubation period of 120 to 150 days, **v.** the eggs survive desiccation in dry mud, and **vi.** after incubation period is over, the eggs hatch out within 24 hours when put in water in the site in which they can be used for mosquito control. The use of annual fishes is further limited to climates characterized by alternate periods of concentrated rain and drought, each lasting for a minimum of 2 to 3 months.

The drought requirement of annual fishes for egg-hatching is an inherent safeguard against their becoming pests in permanent watersheds. At the same time, in large release sites, it may delay the establishment of fish densities sufficient for mosquito control. Thus their large scale use in larval control needs to be further investigated.

FISH HATCHERY

Justification for Maintaining a Hatchery

It is an accepted fact that the use of larvivorous fishes as biological control agents will remain one of the principal methods for control of larval breeding. Therefore the organizations engaged in this work must establish their own hatcheries and maintain mother stocks so that adequate number of fishes are always available for distribution.

1. Site Selection

The hatchery for larvivorous fishes can be established in:

1. A natural water body.
2. A special hatchery can be constructed.

1. The natural water body : The following criteria should be observed in selecting a water body for a fish hatchery:-

i. It should be a permanent water body.

ii. The water should be deep enough so that water temperature does not rise to high levels where fishes cannot survive - usually a depth exceeding one and a half metres is adequate.

iii. The water body should be confined and there should not be a big natural outlet so that fishes do not escape through it. Those perennial water sources with water flowing at constantly high current are not good for a hatchery.

iv. The minimum size of water body should be at least 5 m x 4 m. Higher fish population can be maintained in bigger water bodies. However very big water bodies cannot be looked after properly. The water body of 10 m x 5 m can support a fish population of over 50,000 at a time.

v. The natural water body should be free from other carnivorous fishes which are predators of the larvivorous fish. If these are present, the water body should be made free from predators by catching and destroying them. The larvivorous fishes can coexist with other big herbivorous fishes.

vi. Once clear of predators it should be ensured that the water body selected for hatchery does not get re-infested with them. If necessary a parapet wall around the water body should be made.

vii. The water body should not be contaminated by chemical or other harmful substances and it should be ensured that in future there is no such threat, otherwise the entire mother stock can be lost any time.

viii. The place should be easily accessible for daily or periodic inspection and collection of fishes from the mother stock.

ix. The water body should not be subjected to overflow or flooding. However there should be some constant inflow of water so that the quality of water is maintained and it always remains suitable for fish survival.

2. Construction of Special Hatchery

In case such a water body as described above is not available in the rural or urban area, it is always advisable to acquire a suitable land for construction of a hatchery. Different parameters of a hatchery are :

i. Area - Sufficiently big for construction of 2 tanks of 5 m x 4 m.

ii. Depth - 1.5 m - if depth is increased, cleaning and maintenance become difficult.

iii. The construction may be entirely above ground or partly above and below depending on the local conditions.

iv. Entire tank should be brick lined with good quality cement plaster. The boundary walls should be thick enough to allow the workers to stand on them. Recommended thickness of the wall is 0.5 m.

v. The tank should be divided into two portions of equal size and each portion should be 5 m x 4 m in dimension with common central separator also 0.5 m thick.

vi. The floor of the tank should also be 0.5 m thick and there should be a slope from the central partition towards outer sides. The slope should be 7:5 .

vii. There should be a proper outlet opening of 10 or 15 cm diameter with a plug near the bottom of the tank. Similarly, an inlet of 2.5 or 5 cm size should be provided at 1.25 m height.

viii. If the tanks are built partially below the ground, the parapet should be at least 0.5 m or more above the ground as a precaution against flooding of the tanks during rains or from ground water flow.

ix. There should be a overflow outlet at 5 cm below inlet level protected with proper wire mesh to prevent escape of fish.

x. The bottom of the tank should be uniformly covered with at least 10 cm thick layer of clean sand/earth and the slope should be maintained.

xi. The bottom should be seeded with well compost organic manure at a rate of 2 kg per sq metre. The tank should be allowed to mature for 10 to 15 days before the fish are introduced and during this period plankton population will grow providing adequate food to support fishes.

xii. The water grass or weeds should be planted to provide shade to fishes and a place for young ones to hide from predators but these weeds should not be allowed to choke the tank. Thus periodic pruning is essential. Alternatively a shed without walls can be put on an iron frame and the minimum height recommended is 3 m.

xiii.If it is proposed to maintain a very high population of fishes in the hatchery i.e. 5 to 10 thousand per sq m, arrangements for aeration of the water in the tanks should be made. Air flow level of 2 lit/sq m should be maintained. For every sq m of surface area, there should be one small air inlet near the bottom of the tank.

xiv.With this system of aeration and change of water at a rate of 25%, water change every 24 hours should be provided. This arrangement would support at least 10,000 stock per sq m of water. A high survival rate of 90% and good growth rate are ensured.

xv. In case of egg laying, one compartment of the tank is reserved for spawning and the other for holding grown fishes for use in the field.

xvi. When an optimum fish population is attained in these tanks, the fishes from mother stock are taken to the field and released in larval habitats.

xvii.In the permanent water bodies the fishes will multiply and attain densities sufficient for larval control. If the densities reach proportions which cannot be supported by water body, fishes should be regularly taken out and released in new water bodies for maintaining a healthy stock.

Feeding of Fishes in a Hatchery

Normally no extra food is required if mother stock is maintained in a natural pond. In order to maintain very large number of fishes in a cemented hatchery, apart from change of water and aeration, supplementary food should be provided for rapid growth.

The fishes are fed on live plankton present in nature or pre-cultured separately. The supplementary feed suspension other than plankton is prepared as follows:

Fish Feed Composition

1.	Groundnut cake	18%
2.	Shelled prawn powder or fish meal	18%
3.	Rice bran	18%
4.	Cereal	11%
5.	Egg	35%

OR

1.	Groundnut cake	33%
2.	Rice bran	33%
3.	Wheat flour	33%

All items are mixed and blended thoroughly. The mixture is heated for five minutes, stirred and allowed to cool. The feed is sieved through fine cloth. Water three times the total quantity is added so that a fine liquid suspension is obtained. This suspension is fed six times a day to fishes The daily feed requirement is given in Table- 6.8 .

Table- 6.8 Daily Feed Requirement for Five Lakh Fry According to Age of Young ones

Days	Total Feed for Tanks (GMS)	Total Volume of Feed Suspension (ML)
1.	150	450
2.	150	450
3.	250	750
4.	375	1125
5.	500	1500
6.	1000	3000
7.	1250	3750
8.	1500	4500
9.	2000	6000
10.	2500	7500

Transportation of Fishes

When sufficient stock of fishes have been raised in the hatchery and no mortality is observed in the mother stock, they can be released in the field in larval habitats for control operations.

Collection of Fishes

The fishes are collected from mother stock by netting. For this purpose a circular iron ring of 60 to 90 cm is attached with a nylon net of about one metre length. It is fitted with a wood or metal handle of one and a half metres length. With repeated dips sufficient number of fishes are caught and kept in a drum or bucket with sufficient water till they are packed for transportation.

Long Distance Transportation

For a journey of 12 hours or more, special arrangement is to be made. By rail, bus or air, only small numbers can be sent usually for establishing a mother stock hatchery at a new location.

Method of Transportation

1. Take a polythene bag of three litres capacity

i. Fill it with one and a half litres of water.

ii. Introduce fishes in the bag till the total volume of water + fishes is two litres.

iii. Bubble oxygen in the bag with a flexible tube attached to the oxygen cylinder. The oxygen should be bubbled slowly for a period of 5 to 10 minutes. If the oxygen cylinder is not available, the air can be bubbled by using small cycle pump. Precaution should be taken to pump very slowly so that fishes are not damaged.

iv. Close the mouth of the bag with a string leaving sufficient air space at the top.

v. Put the bag in a thermocol container of the same size and close the mouth of the container tightly.

vi. This container can be transported for a period 24 hours without reintroducing oxygen. If the journey is of a longer duration, make arrangements to change and oxygenate the water.

While doing this, discard dead fishes and repeat all the steps described above in the procedure for packing the fishes.

Note :-

a. i. Normally 15 to 20% mortality may occur. Therefore, take sufficiently large number of fishes to compensate for mortality. **ii.** Do not increase the size of the plastic bag or number of fishes in it, because if this precaution is not observed, the mortality will be very high. While doing reoxygenation of the water, see to it that the temperature of water remains same, neither cold nor warm because fishes do not tolerate sudden temperature changes.

b. Preferably fishes should not be given any food for 10 to 12 hours period prior to packaging for transportation.

2. When large number of fishes are required to be transported over a long distance, Malaria Research Centre recommends that they should be put in a 250 litre barrel or a plastic drum of similar size, 2/3rd filled with water and fishes in same proportion as given for plastic bag. The barrels should not be closed but kept open. The procedure is :-

i. Load the barrel in the vehicle.

ii. Fill the barrel up to half mark with water.

iii. Release fishes in the water, total volume of water and fishes should not exceed 2/3rd mark.

iv. At least 1/3rd of the barrel should be empty.

v. There is no need for oxygenation as the movement of vehicle will agitate water and oxygenation will take place.

vi. The barrel should be covered with a mosquito net cloth.

In case the fishes are transported in a jeep trolley :

i. The interior of trolley should be covered with a water proof tarpaulin.

ii. This is again covered with a plastic sheet.

iii. Both tarpaulin and plastic sheet should hang over the sides of the trolley.

iv. Fill the trolley up to one third depth with water.

v. Release the fishes.

vi. The total volume of water and fishes should not be more than half of the depth of the trolley.

Precaution

When fishes are transported in barrels or trolley, drive the vehicle slowly so that splashing is reduced and loss of fishes due to spillage and injury is prevented.

Short Distance Transportation

In the field, fishes are most commonly required to be transported from the mother stock or one of the water bodies where large number of fishes exist to another water body (mosquito breeding site) or where they are being either introduced for the first time or replenished in a previously treated breeding site or where their number has declined.

The distance involved is small usually from 1 km to 10 kms and the journey by cycle or moped may take 3 to 4 hours when more than one breeding site is to be treated. For this purpose the following procedure is recommended.

1. Equipment

i. 15 lit plastic buckets with handle - two number

ii. 5 litre plastic bucket - one

iii. 5 litre plastic bag - one or more

iv. Larval dipper - one

v. Well net - one

vi. Rope - one - 10 m long.

2. Calibration of Equipment

Put three marks with red or white enamel paint (depending on the colour of the bucket) by drawing a line on the inside or outside surface of the bucket as is convenient to the worker at **i.** 7.5 litre level **ii.** 10 litre level and **iii.** 15 litre level.

3. Procedure

i. Fill the bucket up to 7.5 litre mark with clean water. If necessary, filter the water through a muslin cloth.

ii. Introduce fishes to bring total volume up to 10 litre mark.

Note :-

Each fish is approximately one c c in volume, 250 to 300 fishes can be carried in one bucket.

iii. Both buckets are to be filled with water and fishes in the same manner.

iv. Hang the buckets on hooks attached to the cycle or moped carrier one on each side.

v. Put 5 litre bucket and plastic bag on the carrier along with larval dipper and other equipments.

4. Release of Fishes

To release the fishes in water body, measure the perimeter of water body and release **at the rate of 6 to 10 fishes per linear metre. If the larval density is high, more fishes up to 20 can be realeasd.** Some authorities advocate release of fishes according to area of the water body, but because the larvivorous fishes are shallow water and margin feeders, they even negotiate water weeds to feed at the margins of the water body and this site is also the larval niche in the water body. Therefore the criteria for fish release should be according to the length of the total perimeter and not the area in sq metres.

How to Measure the Perimeter of a Water Body

An easier method for use under field conditions is that a person walks by the side of the water edge all along the perimeter of the water body, **observing precaution to take normal steps** - the number of steps taken are counted, divided by 2. This gives the approximate length in metres with fair degree of accuracy for operational purposes.

Number of steps taken around water body to measure perimeter ÷ 2 = length of shoreline of water body in metres.

5. Precautions

i. Fishes should be released in morning hours before noon or in the evening. Otherwise there may be high mortality as during mid-day the fishes are suddenly exposed to rise in water temperatures on account of solar radiation.

ii. Before releasing fishes, ensure that the temperature of water both in the container and in the larval habitat (in which they are being released) is more or less same. If it is not so, then take some water from the water body to be treated in five litre bucket, put the required number of fishes (number to be released in the water body) in plastic bag and immerse it in the five litre bucket till temperature of water is same in both containers.

iii. Observe the fishes whether they are still active and if so, release them in the water body.

iv. Release the fish in the breeding site slowly by immersing five litre bucket or the plastic bag in the water body and tipping it so that fishes swim out in the breeding site. Do not throw fishes from a height in the breeding site to avoid injury.

v. While releasing the fishes, see that both male and female fishes are released; otherwise their numbers will not increase. Ideal ratio of male : female is 1:3.

vi. Clean out dense vegetation from the water body. Method for cleaning and dressing of the margins is :-

a. Uneven margins of the water body can be made even using a spade. The slope of the edges should not be less than 80 ^{0}.

b. Dense vegetation like wild grasses and aquatic plants like water hyacinth should be removed from the water body.

c. Clean up grass and other plants from the ground along the margins of water body so that the width of one foot ground all along the margin is free from grass and plants. This ensures that vegetation does not hang down over the margins into the water body.

d. At some field stations of MRC, mud plastering of the margins up to a distance of 30 cm from the edge all along the perimeter has proved useful in preventing growth of weeds along the margins for a longer period as compared to a situation when only cleaning and dressing of margins were undertaken.

vii. Ensure that the water body is free from predators of larvivorus fishes.

If the water body is not free from predators, the usual methods to clean the water body are :-

1. Repeated netting : This removes the adult predators easily and repeated netting at suitable intervals depending on predators' growth pattern will ensure removal of younger brood as they grow up and water body will be ultimately free from them.

2. Stunning the fishes with chemical or organic matter and catching.

a. **Disinfectant method :** 10 ppm of Calcium hypochloride (bleaching powder) is used. Acts by reducing oxygen content of water body and the fishes remain edible. The disadvantage is that this method cannot be used repeatedly, as water pH changes. It is costly and the water cannot be seeded immediately with fish; some period is required for dissolved chlorine to leach.

b. **Use of organic matter :** Mahawa cake is used very frequently. The dosage of 2,500 kg/ha or 0.25 kg/sq m is put in a water body (22 to 25 ppm). After some interval fishes float to the water surface. As it reduces the level of dissolved oxygen in water, fishes remain edible. The floating fish is removed by scoop nets. The disadvantage is that the cost is high and the water body cannot be seeded with fish immediately. It takes at least 10-15 days for restoration of oxygen content and other parameters of the water body. The advantage is that it acts as manure also and thus part of the cost is offset. It can be used repeatedly, if waiting time is not a constraint.

However, these methods are not practical for deep large bodies. In such cases repeated netting is the best procedure.

Some authorities advocate use of pesticides in low dosages. **These should never be used because of pollution of environment and fishes.**

6. Follow - up Procedure

i. Visit the water body every week to inspect whether the fishes are surviving.

ii. If all the fishes die, inform the officer incharge/ supervisor to investigate the reasons for the phenomenon, like water characteristics or presence of predators which can cause mortality in fishes.

iii. If only some fishes die, replenish to make up the required density.

iv. Check the water body for vegetation or weeds, the margins should be free from vegetation; if not, take necessary steps to clean the margins.

7. Mosquito Breeding Places Where Fish Can be Released

The water collection should be permanent such as ponds, village Pokhar, some reservoirs, lakes, wells, overhead tanks, etc. Also consult Table- 6.7 where the permanent and temporary measures for control of mosquito breeding in different types of water bodies are given.

EXPANDED POLYSTYRENE BEADS (EPS BEADS)

INTRODUCTION

Reiter in 1978 for the first time suggested the idea of using Expanded Polystyrene Beads to control mosquito breeding. These beads are commonly known as thermocol and are exclusively used as insulating and packing material. The EPS is expanded form of the polystyrene which is manufactured indigenously and available in the form of hard translucent glass like bead granules. Each bead contains an expanding agent. When exposed to high temperature/steam, the bead granules expand about 35 to 50 times of their original volume.

These beads are inert and non-toxic. They are non-wettable and resistant to fresh water, sea water, solutions of salt, soap, wetting agent and also inert to the action of caustic soda, caustic potash, ammonia, liquid manure, lime wash and weak acid solutions. If exposed to strong direct sunlight, the EPS beads turn yellow due to UV radiation and become brittle with long exposure. They are not acted upon by micro-organisms. They are light in weight, non-biodegradable and remain for years on the water surface after a single application.

Mode of Action

This is not a true larvicide. The beads are light in weight. Thus when these are applied on the water surface, a dry floating blanket in several layers is formed on water surface. It is a common knowledge that mosquitoes lay eggs only on the water surface. The mosquitoes are not able to deposit eggs on the water surface covered by these beads as moist or exposed water surface is not available for oviposition. Further, immature stages under the layer of beads die of suffocation in a few days and there is no mosquito emergence from the habitat. In this manner this method achieves larval control in the habitats otherwise suitable for mosquito breeding. Once applied to a mosquito breeding habitat, the beads remain for years. When water dries up, the beads settle down to the bottom or stick to wall of the breeding place. Subsequently when water accumulates, the beads refloat and form a blanket on water surface.

Availability

These are available commercially in India in open market. As the volume of the beads is enormous (1 kg of expanded beads is approximately 57 to 60 litres in volume) their transportation becomes a problem. However, the bead granules occupy 35 to 50 times less space. Therefore, if extensive use of expanded polystyrene beads is contemplated, an expanding machine mounted on a portable vehicle can be purchased which can make the beads from the granules in the field at the peripheral depots from where they can be taken by the field workers for application in the breeding places. Thus, the cost of material and associated manpower can be reduced by at least fifty per cent.

Size of the Beads

The most suitable size of beads is 2 to 4 mm in diameter.

Dosage

450 to 550 gm per sq metre surface area.

If the water surface is not cleaned of debris and vegetation, the beads will not form a uniform layer and oviposition will occur in patches of wet area or open pockets around debris. The calculation for requirement of EPS beads is given in Table- 6.9.

Table- 6.9: Calculation for Requirement of EPS Beads

Diameter of well (m)	Perimeter of well (m)	Area (m^2)	EPS in Kg	Beads requirement in 15 lit bucket
1.0	3.2	0.8	0.4 to 0.5	1.0 to 1.5
1.5	4.7	1.8	0.8 to 1.0	2.0 to 2.5
2.0	6.3	3.2	1.5 to 1.7	4.0 to 4.5
2.5	7.9	4.9	2.2 to 2.6	6.0 to 7.0
3.0	9.4	7.0	3.0 to 3.8	8.5 to 10.0
3.5	11.0	9.6	4.3 to 5.3	12.0 to 14.5
4.0	12.6	12.6	5.6 to 6.9	15.0 to 19.0
4.5	14.2	15.9	7.0 to 8.7	19.5 to 24.0

Precautions in Application

1. Clean the water body of all types of debris and vegetation.

2. See that there are no lumps of beads. If there are such lumps, break them. If some of the lumps cannot be broken, discard them. Generally lump formation is due to poor expansion process.

3. Fill the bucket with EPS beads as per the requirement shown in the Table- 6.9 and apply them on water surface.

4. Before putting EPS beads in cisterns or overhead tanks the outlet opening in the tank should be covered with a wire gauze mesh with hole size less than 2 mm. This prevents the entry of beads into the water supply system.

Water Bodies suitable for EPS Beads Application

Mosquito breeding sites for treatment with beads are chosen on the basis of the following criteria:-

a. The water is stagnant.

b. The water body cannot be drained.

c. The water surface is not subjected to wind currents as slight breeze will carry away the beads and expose the water surface for egg laying.

d. The water from the breeding site is not used and the surface is not disturbed by man or animals. Drinking water sources are not to be treated with EPS beads, lest animals and ignorant children should get suffocated.

e. Water body is permanent or semi-permanent.

f. Water depth is not a criterion for selection.

Usually such water bodies are **disused wells and deep quarry pits** which are not exposed to wind or subjected to flooding. They may have **permanent subsoil water surface or temporary rain water collection**.

EPS beads should not be applied in wells used frequently i.e., drinking water wells, because due to constant use some beads will be drawn up with water, the layer of polystyrene beads gets disturbed and some water surface may remain exposed where mosquito breeding is likely to take place.

Advantages of EPS Beads Application

1. Relatively simple to use.

2. One application usually lasts for several years.

3. Non-biodegradable.

4. Non-toxic and do not contaminate environment.

5. Usually, these are not used for any other purpose by the community and therefore, generally not stolen or cannot be misused.

6. These can neither be adulterated nor used as an adulterant.

7. Indigenously manufactured and easily available.

8. Applied in stagnant water where other methods are not suitable.

9. Cost-effective as compared to other methods of control.

Note:

1. Beads are used in some countries to improvise soil quality as mixing of beads in soil increases aeration.

2. Beads have also been used to fight drought. On large water bodies such as lakes/big ponds application of EPS beads prevents water loss through evaporation.

Other Mosquito Breeding Places Where EPS Beads Can be Used for Control of Breeding of Vectors and Other Mosquitoes

1. Sluice valve chamber.
2. Underground water tanks.
3. Biogas plant pits.
4. Pit latrines.

SECTION - 4
URBAN MALARIA CONTORL TECHNOLOGY

INTRODUCTION

As per the plan of operations formulated at the time of launching of the National Malaria Eradication Programme, all the roofed structures in the rural areas received indoor residual insecticidal spray except urban areas with a population of over 40,000. In such urban areas, the indoor residual insecticidal spray was confined only to the peripheral belt to a depth of 1 to 1.5 km. Antilarval measures were recommended in towns and cities. The implementation of antilarval operations was made the responsibility of the local bodies. Due to financial constraints many local bodies failed to implement the control measures. Though malaria epidemics were recorded earlier in Bombay, Delhi, Lucknow, etc., these could be immediately contained. Hence, malaria in urban areas was not considered as a major problem.

EMERGING PROBLEM OF MALARIA IN URBAN AREAS

The implementation of control measures under NMEP brought down malaria incidence markedly by 1963 and at the same time increasing trend of malaria was observed in some towns/cities. *Anopheles stephensi* was found to be the principal vector and *An.culicifacies* breeding in wet cultivated areas within the town contributed in enhancing the problem.

1. Bottlenecks in the Control of Malaria in Urban Areas

The following major constraints were identified in the implementation of control measures in urban areas:-

i. Most of local bodies were found lacking financial resources to carry out malaria control measures.

ii. The State Govts. did not supplement the resources to bear the extra burden to contain the emerging malaria problem.

iii. Some local bodies which had been undertaking regular antilarval measures either curtailed or totally abandoned the antilarval activities.

iv. The tremendous developmental activities specially construction activities attracted aggregation of labour leading to mushrooming of slums which served as focal points for dissemination of infection.

2. Precipitation of Urban Malaria Problem in Mid-Sixties

Madhok Committee (1969) reviewed the problem and found that 10 urban areas in Andhra Pradesh and Tamil Nadu contributed 11.2% of the total malaria cases in the two States during 1963. The Committee felt that **if effective antilarval measures were not undertaken in urban areas, the proliferation of malaria cases from urban to rural areas might spread** in a bigger way in many States and recommended Central assistance for adequately tackling the programme.

IMPLEMENTATION OF URBAN MALARIA SCHEME

In view of free dissemination from rural areas to urban areas by the frequent movement of people to the big cities in search of employment and on moving out of urban areas, they carried the infection to rural areas that had already been cleared of malaria. Due to serious hazards to the programme on account of urban malaria problem, it was felt that the urban areas with 40,000 population and above having *An.stephensi* problem should be brought under the purview of NMEP for implementing antilarval operations as a complementary to the programme in rural areas.

The Urban Malaria Scheme came into existence in 1971 covering 23 towns initially and now the scheme is in operation in 131 towns in 19 States/UTs covering a population of about 74 million. The main objective is to control malaria by reducing the vector population in the urban

areas through recurrent antilarval measures, since indoor residual insecticidal spray is not acceptable to the urban population.

The norms for establishment of UMS are as follows:- **i.** The towns should have a minimum population of 40,000. **ii.** The API should be 2 or above, **iii.** The towns should promulgate and strictly implement the civic bye-laws to prevent/ eliminate domestic and peri-domestic breeding places.

1. Control Strategy

i. **Source Reduction**: The breeding sources are reduced by minor engineering methods.

ii. **Antilarval Measures - Chemical Methods**: The following chemicals are used for antilarval measures:-

a. Mosquito Larvicidal Oil

b. Temephos

c. Fenthion

The use of Paris green and Pyrethrum based emulsifiable oil is discontinued in UMS Towns due to technical, logistic and financial constraints.

iii. **Biocides**: *Bacillus thuringiensis* and *B.sphaericus* have been introduced in selected areas of some urban malaria towns on a pilot scale since these larvicides are considered to be environmentally friendly.

iv. **Biological Control**: In some urban areas larvivorous fish like Gambusia and Guppy are also used in selected areas where chemical control is not feasible.

v. **Aerosol Space Spray**: 50 houses in and around every positive house are sprayed with 0.1% pyrethrum.

vi. **Antiparasitic measures** : Through passive agencies like hospitals, dispensaries, clinics and private practitioners to reduce the reservoir of infection by early case diagnosis and prompt treatment.

2. Staffing Pattern

Scale on which the antilarval staff provided in UMS towns is as follows:-

A. The antilarval staff has been or should be provided on the basis of the Municipal area of each town to be covered, it should include peri-urban areas up to 3 km belt.

- The staff should be augmented along with extension of municipal limits.

B. The Municipal area is divided into wards of 25.6 sq kms (10 sq miles) each. If a town is less than 25.6 sq kms one ward is allotted.

Each ward is divided into 10 Sectors of 2.56 sq kms each (1 sq mile)

i. Staffing Pattern for a Sector

Scale for regular Antilarval staff for each of 2.56 sq km Sector of the town is:-

a.	Superior Field Worker	-	1
b.	Field Workers	-	2
c.	Field Worker for desilting, deweeding and minor levelling.	-	1

ii. Staffing Pattern for a Ward

Scale for regular Supervisory and Technical Staff for each ward is:-

a.	Malaria Inspector	-	1
b.	Insect Collector	-	1

iii. For towns having up to 40 Sectors, One jeep with trailer is provided, along with a driver.

For towns having more than 40 Sectors, two jeeps with trailers and two drivers are provided.

iv. Generally the staffing pattern will be on the above basis, but minor variations and modifications may be made according to the needs of the town.

v. A Biologist/Antimalaria Officer as overall incharge is provided to supervise the Scheme.

3. Recommended Pattern for the Supply of Material & Equipment to Towns under Urban Malaria Scheme

i. Larvicides

1. MLO 0.5 litres per capita per year.
2. Temephos 0.5 kilo litres per million pop.
3. Fenthion 1.0 -do-
4. Pyrethrum Emulsion 0.05 litres per capita
5. Paris green 1200 kg per million pop.
6. Pyrethrum Extract 1 kilo litre -do-
7. Sup. Kerosene Oil 20 kilo litres -do-

ii. Sprayers

1. Knapsack 4 for every 5 field workers
2. Hand Compression 2 for every 10 field workers

iii. Microscopes for each UMS Town

1. Compound - 2 To be supplied at the time of establishment and replaced only after condemnation
2. Dissecting - 2

iv. Microslides - 10,000 every year

v. Vehicles One jeep with trailer for every Biologist (at the time of establishment) and can be replaced only after condemnation

vi. For the Metropolitan Cities

MLO	700	kilo litres.
Paris green	1680	kg
Pyrethrum extract	1400	litres.
S.K.Oil	28	kilo litres.
Temephos	500	litres.
Fenthion	500	litres.

4. Proportion of Malaria Cases Contributed by UMS Towns

The total malaria cases and percentage proportion of cases contributed by UMS towns as compared to the data pertaining to the country for the period from 1988 to 1993 are given in Table- 6.10.

Table- 6.10 Proportion of Urban Malaria Cases as Compared to Total Cases in the Country

Year	No. of Malaria Cases		Contributed by UMS Towns as Compared to Country	
	Country	UMs Towns	% Total +ves	% *P.falciparum*
1988	1854830	146233	7.88%	2.13%
1989	2050064	202578	9.88%	3.85%
1990	2018783	216632	10.73%	2.61%
1991	2117460	213323	10.07%	2.52%
1992	2125826	195569	9.20%	2.46%
1993	2207431	221622	10.04%	1.38%

It is seen from Table- 6.10. that the overall percentage of malaria cases contributed by UMS towns from 1988 to 1993 ranged between 8% and 11% though the population of the UMS towns constitutes 8% of country's population. On the other hand the proportion of *P.falciparum* cases contributed by UMS towns was markedly low which varied from 1.4% to 3.9%. Though the *Pf%* has been showing an increasing trend in the country almost doubled between 1981 and 1992 but the same trend in UMS towns was not discernible.

RECOMMENDATIONS OF EXPERT COMMITTEE - 1995

The Expert Committee identified 15 major cities including four Metropolitan cities as high risk areas. Besides these, the Expert Committee identified 14 other towns in the country where malaria situation is serious showing SPR 10% and above during any of the preceding three years. Some of the major cities as well as the metropolitan cities contribute very high number of malaria cases. It has been deserved that the City of Madras contributed 45 to 74% of malaria cases in Tamil Nadu during the last ten years.

The high risk areas identified by the Expert Committee include the 29 cities/towns which are given in Table- 6.11 and Table- 6.12.

The Expert Committe also recommended that any other urban area with a population of 50,000 or more and SPR more than 5% or the ratio of clinical malaria cases to fever cases more than one third as per hospital/dispensary statistics during the previous calendar year is to be identified as high risk areas.

Accelerated Action Recommended by the Expert Committee - 1995

The Committee has recommended that case detection mechanism should be introduced in urban areas with immediate effect. This recommendation has been made in view of the fact that other agencies like hospitals, dispensaries and clinics do not report clinical malaria cases to the Urban Malaria Organisation. They also rarely get their clinical diagnosis confirmed by microscopy. Therefore, there is under-reporting of malaria cases from urban areas. Further a large number of towns in the country are not included in Urban Malaria Scheme. About these towns there is hardly any information.

In view of the above, it has been decided that:

i. The organisation for active case detection should be established for fortnightly domiciliary visit in the slum areas.

ii. The passive case detection in the hospitals and dispensaries should be strengthened by establishing a component of malaria post, a worker to collect blood smears from fever cases be provided in OPD.

iii. All fever cases from whom the blood smears are collected should be given presumptive treatment with appropriate antimalarials.

iv. The blood smears collected by the peripheral staff and at OPD of the hospitals will be examined expeditiously to administer radical treatment preferably within 48 hours of blood smear collection.

Case Detection by Voluntary Workers

To provide early diagnosis and prompt treatment of malaria, FTDs may be opened @ one per 2000 population, with a voluntary worker from the slum area population. There shall be at least one FTD holder in each slum. Their functions and duties will be same as FTDs in rural areas.

Staffing Pattern for Case Detection

The staffing pattern for active case detection now recommended by Expert Committee will be as follows:-

a. One worker for 20,000 population for active surveillance in slum areas. The slum area population may be estimated by the local body to provide adequate staff.

b. One worker for strengthening passive surveillance/activating passive surveillance to be posted at each dispensary/public hospital with an OPD attendance of 200 cases per day. In the afternoon, this OPD malaria worker can be assigned active case detection in the population adjoining the institute where he is posted.

Table- 6.11 Cities Requiring Accelerated Urban Malaria Scheme

S. No.	Name of Town	Pop. (in Lakhs)
1.	Delhi	85.00
2.	Madras	39.75
3.	Calcutta	41.43
4.	Bombay	105.06
5.	Hyderabad	15.00
6.	Bangalore	36.80
7.	Ahmedabad	32.00
8.	Bhopal	9.23
9.	Jaipur	10.05
10.	Lucknow	11.50
11.	Chandigarh	6.40
12.	Vadodara	4.11
13.	Visakhapatnam	3.64
14.	Vijayawada	5.43
15.	Kanpur	18.50
Total	**Population**	**423.90**

Table- 6.12 Towns/Cities under Urban Malaria Scheme Showing More than 10% SPR during 1991-93 Requiring Accelerated UMS

S. No.	Name of Town	Pop. (in Lakhs)
1.	Chaibasa (Bihar)	1.00
2.	Bharuch (Gujarat)	1.12
3.	Dohad (Gujarat)	0.56
4.	Godhra (Gujarat)	1.00
5.	Jodhpur (Rajasthan)	5.06
6.	Bharatpur (Rajasthan)	2.05
7.	Bellary (Karnataka)	2.01
8.	Tuticorin (T.N)	0.27
9.	Erode (T.N)	1.73
10.	Dindigal (T.N)	1.19
11.	Rourkela (Orissa)	4.18
12.	Sambalpur (Orissa)	1.80
13.	Nabha (Punjab)	0.49
14.	Dimapur (Nagaland)	0.60
Total	**Population**	**23.06**

Slide Examination and Establishment of Malaria Clinic

Microscopic examination of the blood smears collected by the surveillance workers under the active and passive case detection agencies will be done at malaria clinic(s).

It has been decided to open one malaria clinic for 50,000 population or part thereof. Each malaria clinic will be manned by a laboratory technician trained in malaria microscopy.

- He will maintain all records and send reports as laid down for PHC laboratory.
- The same proformae as prescribed for PHC laboratory will be used by him.
- He will report to the local body, officer in-charge of antimalaria programme, who in turn will send the reports to State Health Directorate and Directorate of NMEP.
- **Location of Malaria Clinics.**

Preferably, Malaria Clinic should be located adjoining to slum area and wherever feasible its location should be in an existing dispensary.

Other details of Urban Malaria Control have been covered in Section- 3 of this Chapter.

SECTION - 5
SUMMARY OF PRINCIPLES OF PLANNING MALARIA CONTROL OPERATIONS

World Health Organisation in its Global Malaria Control Strategy defined the goal of malaria control as:

'to prevent mortality and reduce morbidity and social and economic losses through the progressive improvement and strengthening of local and national capabilities'.

They have enunciated four basic technical elements; one of these is:-

- to provide early diagnosis and prompt treatment.

It was emphasised that primarily malaria control strategy should be a 'disease management' programme.

This activity was given the place of prime importance in the scheme of malaria control. Sustainable preventive measures including vector control and also the early detection, containment or prevention of epidemics were given the second and third priority respectively within the global malaria control strategy.

The meaning of the term **'disease management'** is sometimes confused with **management of 'sickness'** in a person and it is not linked to the management of **'disease entity' in the individual but in its'totality'**, as prevalent in the community.

Infection - Sickness - Disease

At a given point of time malaria **'infection'** can be present in an individual and subsequently as a logical consequence of infection **'clinico-pathological symptoms'** which develop in an individual having malaria **'infection'** and **'sickness'** is manifested requiring immediate management so that a clinical cure can be achieved speedily. However, sometimes the individual may not establish a focus of the disease in the area or in other words secondary cases may not arise from the primary case. The establishment of a focus of 'malaria disease' in a community will depend on the presence of the vectors in the locality coupled with other conditions favourable for disease transmission.

Disease Management Concept

Looking at the history of control of infectious and communicable diseases, it appears that the concept of **'disease management'** arose out of successful global efforts on smallpox eradication. The entire programme was planned on detection and management of a smallpox case in the community. In smallpox there was the 'search and containment' strategy, i.e. search for cases, their isolation and vaccination in the immediate vicinity of cases. The public health planners having successfully achieved smallpox eradication through `disease management' and later gave emphasis to `disease management' as practised in control of infectious disease for communicable disease also. **They completely overlooked that the same concept cannot be applied to a'communicable disease model'. In malaria, 'a malaria case - sick person' is only a small part of the total profile of the 'disease entity' as observed in the community.**

Management of 'Sickness'

A malaria infection in an individual will lead to **clinico-pathological manifestations** which would require immediate management. The emphasis has been laid down on early diagnosis and prompt treatment of a 'sick person' Here again, the **emphasis is more on 'clinical cure'** irrespective of microscopic diagnosis and the schizonticidal antimalarial drugs are administered to achieve a 'clinical cure' and **to reduce 'duration of morbidity'. Emphasis on chemoprophylaxis** to vulnerable group(s) is given. **The chemoprophylaxis is aimed at prevention of clinico-pathological manifestations in an infected person,** usually short term visitor in an endemic area. **As a part of complete treatment, administration of gametocytocidal drugs has not found the place of importance they**

deserve. Therefore, the EDPT confines itself to early diagnosis of infection by identifying sickness as exhibited through development of clinico-pathological manifestations and the management of a sick person to attain an early clinical cure.

The profile of malaria disease is not complete if its transmission dynamics and mode of perpetuation of malaria infection in a community are not taken into account while talking of 'disease management'.

Therefore, 'disease management' should give equal emphasis to i. EDPT, ii. administration of gametocytocidal drugs to individuals with malaria infection and iii. simultaneous implementation of intervention methods for reduction of malaria transmission in the locality.

Only the transmission control measures will prevent secondary cases in the community where disease transmission is possible. In South East Asian Region transmission of malaria is seasonal, although the quantum of transmission may differ from place to place and the transmission in almost all areas is during rainy months only. It is imperative that in this region intervention measures for transmission reduction should form an equal and integral component of malaria control operations because technically it is easier to reduce/interrupt transmission in areas where it is not perennial.

In the light of the above facts, selection of intervention measures for malaria control operations is summarised as under:

Early Diagnosis and Prompt Treatment

Justification

- Early diagnosis and prompt treatment of malaria cases are necessary to reduce the period of morbidity in an infected individual. There are several situations and they are discussed below:-

Detection and Treatment Options

- The mechanism of early detection of malaria cases will depend on the availability of health infrastructure in the country.

If early case detection is based on clinical diagnosis alone, then it is not possible to ascertain the parasite species infecting the case at the time of detection. Therefore, **a full treatment with schizonticidal drug usually Chloroquine along with gametocytocidal drug should be administered on priority basis.** This is suggested because if gametocytocidal drug is not administered, a *P.falciparum* case will continue as a carrier and transmission of *P.falciparum* will take place in the locality.

- The same treatment schedule will also be applicable in areas where the case detection is done on the basis of screening of fever cases through Active Case Detection (ACD) or Passive Case Detection (PCD) or the fever screening by voluntary agencies (DDC or FTD). Again the administration of schizonticidal drug with gametocytocidal drug as a presumptive treatment should be the first choice.

Case Detection through Microscopic Diagnosis

In a situation where microscopic confirmation is immediately available, *P.vivax* cases are given only schizonticidal drug like Chloroquine which also acts on *P.vivax* gametocytes, thereby abolishing the carrier stage of a *P.vivax* case. A microscopically confirmed *P.falciparum* patient is administered a schizonticidal drug with gametocytocidal drug. This drug schedule should be given as a rule to prevent transmission of malaria from such a patient, because mature gametocytes of *P.falciparum* are not affected by Chloroquine and only a gametocytocidal drug acts on them thereby terminating their carrier status. Only later *P.vivax* case can be given antirelapse treatment.

Regarding intervention measures for transmission control/reduction, the planner of transmission control operations can choose from any of the following options depending on the transmission dynamics of the malaria paradigm of the locality.

Planner of a malaria control operations should always remember that selection of intervention measures for transmission control is governed by biting propensity of vector and human socio-economic activity in a community. These two facets of transmission dynamics determine the place and time of man vector

contact and the intervention measures are aimed at preventing this.

The planner should also keep in mind that it is very difficult, if not entirely impossible, to change vector bionomics or human socio-cultural attitudes. Therefore control measures chosen should not clash with these characteristics of vector and human society.

Intervention Measures Characterised by Indoor Man - Mosquito Contact

i. In paradigm where the vector is **'endophagic'** and **'endophilic'**, the reduction in transmission can be achieved by residual insecticidal spray. The options and choice of insecticide to be sprayed as well as criteria for selective spray have been discussed elsewhere in this chapter.

- In areas where the chemotherapeutic option of giving a schizonticidal drug with gametocytocidal drug as a presumptive treatment is followed, it may not be necessary to cover the entire transmission period with residual insecticidal spray. Depending on the capabilities and availability of financial resources, the countries can adopt any of the following options of residual insecticidal spray.

a. The entire transmission period can be covered with insecticidal protective umbrella where finance and manpower are not constraints and availability of adequate insecticide is ensured and the community acceptance is universal.

b. In case of financial and manpower constraints, the insecticidal umbrella should be applied to cut off the peak transmission period. This will achieve reduction in *P.falciparum* cases in the community.

c. In case of severe financial constraints the planned insecticidal residual spray should include areas with malaria mortality, projects and epidemic prone villages.

d. Epidemics/contingency reserve of insecticides should be available to conduct insecticidal residual spray on emergency basis.

There is no need to spray cattle sheds. Only human and mixed dwellings are to be sprayed.

Intervention Measures Dependent on Indoor Man-Mosquito Contact after the Inhabitants go to Sleep at Night

Where the vector is **'endophagic'** and **'endophilic'**, biting activity starts **after 21.00** hours and the peak biting is after midnight, effective control can be achieved also by use of **impregnated bednets**, provided the community can be motivated to use them properly as a part of malaria control operations.

Measures to Combat Indoor Man-Mosquito Contact in Situations Where Vector Avoids Sprayed Surface after Meal

In areas where vector is **'endophagic'** but **'exophilic'** and it is also an early biter, the residual insecticidal spray in the houses may be applied, although the impact of residual spray will be limited. In areas with very high transmission potential and high degree of anthropophilic behaviour of vector with *P.falciparum* predominance, it is necessary to prevent/delay emergence of resistance strains. This is usually achieved by cutting down or reducing transmission in the area and that is why insecticidal spray is suggested.

If the local vector is a late biter and peak biting activity is observed after midnight, the impregnated bednets will be the effective measure for transmission control.

Intervention Measures to Combat Transmission by Intra/Peridomestic Breeder and Indoor Man - Mosquito contact

In case the vector has limited breeding sites which can be easily enumerated and mapped, the operation of choice for intervention measures for transmission control will be the implementation

of antilarval operations and domestic water management.

Intervention Measures in an Area with Multiple Factors Affecting the Transmission Dynamics

- In a migratory population which stay in temporary hutments at the project site, the chemotherapeutic measures coupled with a suitable mix of integrated control operations like residual insecticidal spray, provision of impregnated bednets and selective antilarval operations are necessary. These operations will cost much more than the planned control operations in urban or rural areas, but it is worthwhile. If malaria is controlled properly in the migratory population of a project, they will not be able to start a focal outbreak in their native places. Added advantage of implementing a mixture of all methods is that interruption of transmission can be quite early and emergence of a resistant strain of *P.falciparum* can be avoided. The resistant strains of *P.falciparum* are commonly seen in industrial development and mining project areas.

A planner of malaria control operations should advise the National Government that an industrial or water resource development or an irrigation project should have a full-fledged malaria control organisation including both chemotherapy and intervention measures for transmission control. This would help in achieving the aim of preventing a focal outbreak in the area. **The control strategy along with appropriate organisation to implement it and suitable for use in project areas should be developed in consultation with a body of malaria experts and it should form an integral part of project development with adequate financial outlay.**

Intervention Measures for Transmission Control in Areas with Day time Outdoor Man-Mosquito Contact

There is no known technology which can effectively interrupt this type of transmission and if chemotherapy alone is practised with a gametocytocidal drug, selection of resistant strains of *P.falciparum* can be delayed. Only answer to this type of transmission dynamics is development of a polyvalent vaccine which can provide long lasting immunity against locally prevalent malaria parasite species.

Priority Allocation Among Health Activities

Nothing will succeed, unless appropriate priority is given to malaria control within the health sector. The past experience has shown that Primary Health Care System, as it exists in the country, is not capable of implementing the malaria control activities on priority basis. The Primary Health Care Organisation should be suitably strengthened at different echelons by a mandate from the political and administrative body to meet the needs of malaria control activities with full dedication and determination.

SECTION - 6
DECENTRALISATION OF MALARIA CONTROL OPERATIONS

In its revised global strategy for malaria control, 1993 World Health Organisation has emphasised decentralization of malaria control activities. This is a continuation of WHO policy of health care delivery through Primary Health Care System with the multipurpose workers at the peripheral level. They have also emphasised decentralisation of decision making at the community level. Such a step is expected to meet more effectively the local needs of malaria control.

Concept of Decentralisation and its Impact

The process of decentralisation as advocated today has not been discussed or even rationally conceptualised in detail. The impact of decentralisation has not been evaluated by experts in respect of malaria control measures. It is a fact that as a direct consequence of poorly managed and politically motivated process of simultaneous integration with general health care system and decentralisation of malaria control activities, the effectiveness of national malaria control programme has declined often resulting in adverse socioeconomic impact on vulnerable population like children and pregnant women. The process has resulted in malaria control activity losing its key distinguishing feature of dedication for achieving maximum results through field operations in the control of malaria.

Through the decentralisation process the unipurpose surveillance worker who was exclusively devoted to containment of malaria has disappeared. He has been replaced by the multipurpose worker of primary health care system who assigns lowest priority to malaria control activity out of many health problems which have been entrusted to him because of the arduous nature of time-bound work under malaria control.

The effective implementation of malaria control through a well organised and ably managed programme had many field problems which were surmounted through hard work by the national, state, district and peripheral level workers. The problems increased during the process of integration resulting in overloading of an inadequate and fragile health care delivery system.

Over the last two decades the process of decentralisation and integration has resulted in depletion of expertise at national and state levels. The present system can hardly cope up with epidemic situations arising out of epidemiological profile of the area because of absence of quick response capability of primary health care system. The logistic support and technical guidance for early diagnosis and prompt treatment as well as implementation of intervention measures for transmission interruption have suffered due to absence of proper analytical and evaluation expertise which has dwindled over a period of time.

Decentralisation cannot be applied uniformly in all malaria paradigms. The extent, timing and process of decentralisation should be well planned keeping in mind the epidemiological needs of different paradigms

It is necessary to distinguish programme priorities, technical requirements, functions and activities necessary for malaria control before taking policy decisions for decentralisation of malaria control activities and delegating the responsibility of decision making to local health functionaries/community. The functions like policy decisions on control measures, field supervision, monitoring, assessment and evaluation require a high degree of expertise to achieve the goals set for malaria control.

Therefore indiscriminate decentralisation of all functions at different levels of functionaries and leaving the decision making to these health personnel are not recommended.

There is urgent need to consider:-

1. What is to be decentralised i.e. what functions and decision making in respect of these functions can be entrusted to local level worker ?

2. When to decentralise ? : *inter-alia* this presumes that appropriate time for decentralisation has arrived. This can only happen when local functionaries have been trained and have developed fair degree of expertise in discrimination and priority allocation to different functions required for malaria control.

Considering the above, the decentralisation of all aspects should be carried out after consideration of functions and capacity of different functionaries in the health care delivery system.

The national level should have enough expertise:-

- To lay down policy decisions, direction on control strategy to be adopted;

- To discriminate what is best in the interest of overall epidemiological situation and resources of the country which include man, material and money.

- The experts should be entrusted to locate adequate resources for implementation of the strategy.

- They may also provide suitable guidance to peripheral workers from time to time wherever required.

- The central policy decision making expert body should lay down standards and norms for implementation of malaria control activities.

- They should also provide guidelines for the operations and actively evaluate and validate the programme operations.

- **This expert body can also identify the malaria control activities which are more effective at the peripheral level as well as those which should never be applied due to their potential hazardous nature.**

Primary Health Care System and Decentralisation of Malaria

This requires setting up of a body of technical experts at the national level for taking policy decisions on decentralisation of the current malaria control activities. In the context of primary health care organisation they will assess its capabilities to undertake and implement in the community technically sound malaria control operations on a sustainable basis. They may also include in their plan of decentralisation, the role and responsibilities of each echelon of primary health care system and lay down required input and expected output of each functionary.

This will also require simultaneous strengthening at State, district and peripheral levels, so that the field activities can be carried out to suit the needs of malaria control programme.

Strengthening at Intermediate Level

Adequate expertise should be developed at different levels by appointing staff who are well trained to make technically sound decisions regarding malaria control operations at the field level. It will suffice to give a single example to alert the country's administrators, planners, politicians and community how hazardous it is to leave decision making in the hands of incompetent and untrained persons. In one of the urban areas malathion fogging was practised for control of mosquito nuisance and malaria. At a point of time there was no stock of malathion with municipal authority. A decision was taken by a person not technically competent or trained in use of insecticide to fog the area probably with a hazardous insecticide not cleared for fogging operations and as a result a large number of persons living in the area where fogging was carried out suffered with acute toxic manifestations requiring emergent medical attention. How many among them will suffer permanent health impairment, only time will tell. Therefore technically competent experts should be involved in decision making when a change in control policy is involved .

Management Information System

When it was a vertical programme, the management information system under the NMEP was efficient and quick. The system could be utilised for decision making within a short period of time. The management information system under the primary health care organisation is more cumbersome, time consuming and associated

with delays in communication to appropriate authorities where data could be utilised effectively for analysing and providing feedback for corrective action. The disaggregation of data on malaria at Primary Health Centre, on village-wise level is not done regularly and continuous data are hardly available. This situation arises due to inadequate supervision of PHC malaria microscopist who is entrusted with data maintenance. The field data now under Primary Health Care System passes at least through two additional channels i.e. PHC-MO and CMO of district who have least interest to analyse this information and usually prove to be a bottleneck in data transmission to appropriate authority. As such delay in decision making is likely to result in extension of the problem which can adversely affect surrounding areas and other sections within as well as outside the State. The action is to be approved by a level where such repercussions are studied more rationally keeping in view the overall profile of the disease. The timely feedback to the peripheral level is essential for reducing morbidity, eliminating mortality and liquidating epidemics in an area which is sadly lacking at present under Primary Health Care System.

Utilization of NGOs in the National Programme

Many NGOs and voluntary workers from the community representatives have been utilised in different countries in malaria control activities with variable achievements. It has been found that when regular activities of malaria control like spray were entrusted to these organisations, the execution and quality of operations were invariably poor without producing desired impact on malaria situation.

On the other hand, the voluntary agencies and community organisations have provided good support in early diagnosis and prompt treatment of cases resulting in reduction of morbidity and mortality.

Privatisation of Malaria Control Operations

Another facet of decentralisation is the process of selective privatisation of health activities. There is a trend to advocate this approach for the developing countries. The developing countries are not yet ready for this experiment. Because malarious countries are usually underdeveloped and have a large population spread over a wide area, sometimes population densities are as low as 10 or less per sq km, this proves to be a great drawback, because the private sector's network is not fully developed, it is not ready to undertake malaria control activities in remote and inaccessible areas with adverse conditions. Their cost-effectiveness and credibility are yet to be established. On the other hand in many developing countries the primary health care organisation has reached to the peripheral level and thus can deliver health care in remote and isolated pockets. Other drawbacks of privatisation will be the maintenance of quality of operations and enforcement of drug policy, use of insecticides and selective vector control measures. At present almost all governments in the developing countries do not have a mechanism or appropriate organisation or expertise to enforce the required quality control in case the malaria control activities are given to the private sector.

Treatment of malaria patients by private practitioners should not be confused with privatisation of malaria control. A medical practitioner is primarily concerned with remission or cure of clinical manifestation in a sick person. The medical practitioner does not consider himself a part of well planned malaria control activity. Even the treatment schedule and antimalarial drugs used are based on his individual liking and it is at variance with national antimalaria drug policy. This approach is detrimental to national interest in the use of antimalarials.

Decentralisation of Financial Resources

The discussions on the topic of decentralisation of malaria control activity will not be complete if financial resources are not included in the subject. In the system of central planning and decision making, adequate financial requirements are allocated by the national government and funds are released periodically to intermediate and peripheral units. The funds are earmarked in advance and included in national health allocations. In case the national resources are not adequate and external assistance is required, the

national government negotiates with bilateral or international agencies for assistance or loan. In many countries, the logistics support to malaria control operations necessitates purchase of insecticides, transport and other equipment from foreign countries, as the national capacity may not be adequate to meet the requirement of malaria control activities. Such purchases require allocation of foreign exchange. In almost all countries, the foreign currency and loans are regulated by national government. Therefore, if the planning is done at the national level, the negotiations with bilateral or international agencies and purchases from foreign countries can be concluded speedily. The long - term availability of foreign financial support and material and equipment can be ensured.

If the financial aspects are decentralised, negotiations with international and bilateral bodies by the States (intermediate) or peripheral bodies are difficult as they will have to be within the framework of national policies on these subjects. These bodies will have to make arrangements at national level for financial negotiations involving foreign purchases and foreign exchange.

The States (intermediate administrative areas) or local community have very little resources of their own and many other local problems have priority for financial allocations because local politicians may relegate malaria as a low profile subject. The local community will have to raise funds from within the community for malaria control or ask for financial aid from other sources. It is usually difficult to arrange funds for social projects like health, where financial assets are not generated directly by public health sector and repayment of loans has to come from other financial funding sources such as national debt on consolidated national funds. Therefore, in almost all countries, the intermediate administrative area i.e. States and local community mostly depend on aid or subsidy from national government.

How much allocation the local community can obtain from the national government depends on how forcefully the claims are put up to appropriate department with supporting technical data. As already discussed, most of the local bodies do not have expertise to collect such data and put up the proposal to the State/Central level to support malaria control activities. Therefore, decentralisation of financial resource allocation and asking the community to raise their own funds for implementation of malaria control activities will not succeed.

To conclude, the policy decisions should be taken by the Centre, the guidelines for operations should also be laid down by the Central body along with appropriate financial allocation. The States i.e. intermediate administrative unit, districts and community should be involved in collection of appropriate data which would help in selection of control technology most suitable for control of malaria in the locality. The functions like implementation of EDPT and some other aspects of transmission intervention measures can be entrusted to the district and community level.

It may again be emphasised that privatisation of malaria control activities is not feasible and should not be done at this point of time or for the next few decades. The decentralisation of policy and decision making should be deferred at present. The other activities which can be decentralised at local level will depend entirely on development of expertise or expert bodies well acquainted with malaria control operations at Central, State and district levels.

A scheme of decentralisation of various functions under malaria control operations is presented in Table- 6.13.

TABLE- 6.13. DECENTRALISATION OF MALARIA CONTROL ACTIVITIES

Activity	Central/ National	State/Inter mediate Level	District or PHC	Community	Remarks
Policy Decisions					
Priority allocation for malaria control within health sector	+++	+++	-	-	It should be a joint decision of both Centre & State policy makers
Organisational structure within the health care system	+++	+++	-	-	Joint decision. It may include modification & flexibility to meet State needs
Financial allocation; Policy decision	+++	+++	-	-	Central responsibility, to be jointly decided by State and Centre
Central share	+++	-	-	-	
State plan and State share	-	+++	++	+	By the State in consultation with District and Panchayat, flexible on local needs
- Preparation of policy document	+++	++#	-	-	#Consultation with the States wherever necessary for providing desired flexibility
- Preparation of Guidelines or Operational Manual to implement policy decision	+++	-	-	-	
Selective Vector Control					
- Guidelines	+++	+	-	-	
Strategy Planning					
Intervention measures for transmission control	+++	+++	++#	+#	**#i.** Participate through background data collection **ii.** Expert consultation with malariologists for technology selection

Activity	Central/ National	State/Inter mediate Level	District or PHC	Community	Remarks
- Selection and use of insecticides	+++	+++	-	-	**iii.** If necessary, foreign experts are consulted by country's health authorities
- Selection and use of larvicides	+++	+++	-	-	
- Periodicity of application of intervention measures	+++	+++	#++	-	#Data generation to help in policy decision
- Selection criteria for application of intervention measures	+++	+++	-	-	
- Criteria for application of chemical, biological or environmental methods of larval control	+++	+++	#++	++	#Data generation to help in policy decision
- Implementation of bioenvironmental and antilarval measures	-	-	++	++	
- Evaluation of operations and results	+++	+++	++	-	By National and State organisations, Supplemented by local manpower and resources
Early Case Diagnosis and Prompt Treatment (EDPT)					
- Organisational pattern policy	+++	+++	-	-	**i.** Joint consultation, **ii.** Local augmentation, strengthening within the National policy
- Frequency	+++	-	-	-	

Activity	Central/ National	State/Inter mediate Level	District or PHC	Community	Remarks
- Role of voluntary workers	+++	+++	+	#+	#By selecting suitable volunteer
- Antimalarial drug policy	+++	-	-	-	In consultation with experts in chemotherapy and other fields of medicine and drug controllers of National Government
- Ensuring availability of drugs	+++	-	-	-	Through National Drug Policy on manufacture and sale of drugs, identification of sale outlets, etc.
Logistics					
- Insecticides and Larvicides procurement	+++	+++	-	-	Centre to procure those which require imports and foreign exchange, rest by the States
- Estimation of requirements	+++	#+++	#++	#++	#**i.** By giving projected population at risk **ii.** Estimates of stock position of State and periphery **iii.** Overall scrutiny by Centre to ensure insecticide usage conforms with National Policy
- Procurement of insecticides etc.	+++	+++	-	-	Placing orders for supply of insecticides selected for use
Selective Vector Control					
- Implementation	-	-	+++	+++	

Activity	Central/ National	State/Inter mediate Level	District or PHC	Community	Remarks
- Spray operation application and supervision	-	-	+++	++	
- Supervision and monitoring	-	+++	++	++	
- Monitoring overall plan progress	+++	+++	++	+	
Evaluation of Technical Impact					
- Collection of parameters	-	-	++	++	
- Evaluation	+++	+++	++	-	
- Decision to change or continuation of operations	+++	+++	-	-	As a part of policy decision, Centre to evolve new policy in with States
consultation	by the experts				
Preparedness for Epidemic Outbreak					
- Early information	-	-	+++	+++	
- Monitoring	-	++	+++	-	
- Policy for epidemic control	+++	±	-	-	
- Implementation of epidemic control measures	+++	+++	+++	++	
- Evaluation of epidemic control operation	+++	+++	±	-	
- Personal Protection Policy	+++	++	-	-	Policy decision by experts

Activity	Central/ National	State/Inter mediate Level	District or PHC	Community	Remarks
- Field Implementation	-	-	+++	+++	
- **Budgeting**	+++	+++	++	+	Under decentralised budgeting from Panchayat upwards.
- Provision of subsidies	+++	+++	-	-	
Capacity Building (Training)					
- Trng. of trainers	+++	-	-	-	By expert faculty drawn from Malaria Experts panel
- Preparation of modules	+++	-	-	-	Epidemiologists, Administrators Technocrats at Central & State levels and Public Health Specialists
- Basic training of District level Officers	+++	-	-	-	
- MO PHC	-	±	++	-	
- Lab. Technicians	-	±	++	-	
- MPW (Supervisor)	-	-	++	-	
- MPW (Male & Female)	-	-	++	-	At District & PHC level
- FTD/DDC/Link Worker Anganwadi Worker	-	-	++	-	-do-
- Seasonal spray men & supervisor	-	-	++	-	-do-
Health Promotion					
- Prototype material	+++	-	-	-	
- Modification to meet Local requirements	-	+++	-	-	
- Execution through national and other media channels	+++	+++	+++	+++	

SECTION - 7
PREDICTION AND CONTROL OF MALARIA EPIDEMICS

INTRODUCTION

An epidemic is defined as the occurrence of sickness of similar nature in the community clearly in excess of normal expectancy derived from common propagative sources. Normal expectancy is in terms of number of persons sick with the same sign and symptoms over a period of time in an area. In case of malaria, the epidemic situation is suspected if a large number of fever cases report to the OPD of PHC/Dispensaries, Hospital and majority of these cases are clinically suspected to be suffering from malaria.

Periodic Epidemics - These are:

a. Cyclical Epidemics Occur at 7 to 10 years intervals in India

b. Seasonal Epidemics:

Fluctuations in malaria incidence during rainy, winter and summer seasons.

In areas where control activities are disrupted, the focal outbreaks (i.e. **localised seasonal epidemics**) occur usually leading to high morbidity and mortality due to malaria.

KEY FACTORS TO BE MONITORED FOR PREDICTION AND EARLY DETECTION OF MALARIA OUTBREAKS

The following are the key factors which usually signal a warning that helps in prediction and early detection of a malaria **focal outbreak.** M.O. PHC/ DMO should carefully and regularly watch for them.

i. Parasite Load

Look for variations/increase in

- Number of fever cases.
- Species distribution - *P.v. : P.f.*

ii. Vector Dynamics.

- Increase in mosquito density.
- Increase in vector density.

iii. Population Dynamics

- Influx of migrants from non-endemic to endemic areas and *vice-versa.*
- Tropical aggregation of population in projects.
- Large labour movement to forest or for agriculture.
- Population migration during floods and drought.

iv. Environmental/Climatic Conditions

- Early and heavy rainfall in pre-transmission period i.e. May/June in Northern India.
- Increased humidity during above period.
- Natural disasters like
  - * Floods following monsoon rains.
  - * Drought resulting in drying up of river bed and other water bodies with pool formation.
  - * Earthquake, etc,.

In case there is a gross palpable variation in any of the above four factors the MO PHC/DMO/ MO I/C mobile epidemic control unit should undertake the systematic investigations as mentioned below to confirm and delineate epidemic zones.

MONITORING OF MALARIA INCIDENCE

It is, therefore, necessary that the Medical Officer of PHC and District Malaria Officer should keep a watch on malaria incidence in the community.

a. The malaria incidence of the current month should be compared with the incidence of preceding year(s) during the same month. For example the incidence of July, 1994 should be compared with the incidence of July, 1993 and so on.

b. The second determinant is the **'trend'** of malaria incidence in the area during the year under investigation i.e. month-wise malaria incidence, trends for two consecutive years are compared. In this case, any unusual increase or decrease in the malaria cases over a period of time is analysed.

If the PHC Medical Officer analyses the data in MF-9 (village-wise register of the PHC), he cannot miss any unusual change in malaria incidence in the community/villages. He can analyse the trends of incidence in different villages *vis-a-vis* the number of fever cases from the same area reporting to PHC OPD. This is one of the important steps taken by thePHC in analysing the malaria situation for monitoring an epidemic build-up.

Other sources of information are:

a. Rise in malaria positivity rate in the laboratory examination.

b. Rising fever incidence reported by **i.** FTD holder/MPW **ii.** Community leaders, **iii.** Press, **iv.** Legislature and **v**. Medical Practitioner(s) of the area.

Such reports should be carefully assessed along with laboratory positivity rate of the area. If the positivity rate is high, it is likely to be the beginning of a malaria epidemic in the area and requires immediate careful investigation.

Cross-Check of Laboratory Results

The high positivity rate in the laboratory should be confirmed by cross - checking of the positive slides by an independent laboratory technician/ Medical Officer, PHC.

If the laboratory diagnosis is confirmed, the first action taken is to delineate the areas/ population affected.

OR

If the laboratory diagnosis is not correct as confirmed by high discrepancy rate in cross-check results, check the laboratory equipment such as microscope, JSB stain, quality of blood smears and their staining and ascertain that the results of backlog slides examined are correctly reflected in the corresponding month. The laboratory technicians and MPWs etc. should be given a refresher training, if required.

If there is **low slide positivity** rate as reported by the laboratory, but the **high fever rate** reported by the sources enumerated above, it is necessary that the MO PHC clinically assesses the cause of high fever rate and if high number of clinical malaria cases are observed, then MO PHC should check MF-9 for confirming regularity of domiciliary visits at fortnightly intervals to the villages. This gives an idea about adequacy of coverage or otherwise under case detection by MPW/FTDs.

If some villages had not been visited by MPW (Male) for a long time, carry out rapid fever survey in such villages to ascertain the current malaria situation.

If an epidemic is predominantly of *P.vivax* infection, THEN it is certain that first round of insecticide had not been given in time as scheduled or coverage was poor. FURTHER the case detection/drug distribution was not done for AT LEAST 2 to 3 months.

If an epidemic with *P.falciparum* predominance is seen with deaths of microscopically confirmed *P.falciparum* cases, THEN both rounds of insecticidal spray were either not given or coverage was extremely poor. FURTHER case detection and drug distribution were not done for AT LEAST 4 to 5 months.

On the basis of the above dictum the administrative action should be taken.

DELINEATION OF AFFECTED AREA - RAPID MALARIA SURVEY

Having ascertained that there is an epidemic situation in some of the villages of PHC, the PHC Medical Officer/District Malaria Officer will make arrangements for delineation of the epidemic area and to find out the extent and severity of the epidemic.

They will immediately inform the Mobile Malaria Epidemic Control Team* at District level.

* Note:- The composition and other details of the team are given in Chapter- :7 Section:2

the Zonal Officer and State Programme Officer to help in the delineation of the area and implementation of containment measures on a war-footing.

1. Rapid Fever Survey -

During Rapid Fever Survey, every village in the suspected epidemic zone is covered and only fever cases or cases with history of fever are taken up and their blood smears are examined.

2. Mass Survey -

As an alternative, mass survey of the entire population shall be carried out in every village irrespective of age & sex or fever status. Specially children must be included in survey.

It is necessary to expand the area of survey centrifugally from the epicentre of the epidemic till areas with normal positivity rates are reached. Thus the size of the area involved in the epidemic zone is delineated

To carry out the surveys, it is always advantageous (1) To **establish field laboratories** by pooling laboratory technicians from adjoining PHCs, Districts, Zonal Office or State Headquarters laboratories and pool the peripheral staff from the PHC area to collect blood smears so as to cover the entire population as quickly as possible. **This operation should be over in 7 to 10 days.**

- **Blood smears collected should be examined within 24 hours.**

- **All age groups should be covered specially high risk population i.e. children, pregnant women and migrants.**

- **All persons whose blood smears are collected should be given presumptive treatment with Chloroquine or mass radical treatment with a single dose of Chloroquine and Primaquine**

- **All positive cases should be given radical treatment at the recommended doses.**

Estimation of Population Involved

The next step in the exercise is to calculate the population involved in the epidemic areas. This can be done by taking the village-wise population from MF-1 or the census population of the villages identified, whichever is readily available at the PHC.

Epidemic Control Proforma - 1

List of villages within the malaria Epidemic Zone

P H C________ Subcentre________

S. No.	Name of Village	Population	No. of Households
1.	2.	3.	4
1.			
2.			
3.			
4.			
contd.			
Total			

MEASURES FOR LIQUIDATION OF FOCI

Having ascertained the population at risk and the number of households in which measures to liquidate the epidemic are to be implemented, the antivector and antiparasitic measures should be planned as under.

1. Antivector Measures

a. Space Spray

i. Every house in all the villages of the area affected by the epidemic should be covered.

ii. Indoor space spray should be carried out for 7 to 10 consecutive days or till the residual insecticidal spray in all houses of the locality is completed.

The equipment required for space spray will be a hand operated micro-discharge fogging machine/hand operated atomisers.

Insecticide for indoor space spray will be pyrethrum.

b. Residual Insecticidal Spray

i. The indoor residual insecticidal spraying operation should be started simultaneously with indoor space spray.

ii. The insecticide of choice will be the insecticide to which the local vector is amenable to control.

iii. Apply the recommended dose of insecticide chosen.

- **Cover all houses and sleeping rooms**
- **The cattle sheds need *not* be sprayed.**

c. Urban Areas

The space spray with Pyrethrum should be done in 50 households in and around a positive household.

Intensify antilarval operations in addition to **indoor space spray,** and carry out Rapid Fever Survey. Give presumptive treatment to fever cases and Radical Treatment to all positive cases.

2. Other Measures

Apart from space spray and residual insecticidal spray, some-times it may be necessary to resort to other antivector measures. Such measures should be implemented on the basis of results of entomological findings.

3. Entomological Investigations

The Zonal Officer should depute the Zonal Entomological Team to carry out vector density studies. They should report the findings to the Medical Officer incharge of epidemic control measures. They should point out the prolific breeding places requiring immediate action.

If the epidemic is due to predominance of vector breeding in water storage tanks or in peri-domestic water collection, it will be necessary to undertake antilarval measures along with space spray and residual insecticidal spray.

Later on the detailed entomological investigation may be carried out to ascertain the susceptibility status of the vector(s) in the locality.

4. Duration of Epidemic Control Measures

The entire exercise should be completed in a period of 7 to 10 days and in any case not exceeding a fortnight (i.e. within one extrinsic incubation period) so that secondary cases are prevented.

5. Follow-up Action

To see the impact of remedial measures, it is necessary to take the undermentioned follow-up actions.

a. Carry out mass survey or rapid fever survey in the area where remedial measures have been implemented. The same procedure as mentioned for the first survey is to be adopted and field laboratory is established.

b. Two consecutive follow-up surveys are to be carried out; the first survey 21 days after remedial measures are completed and the second survey 21 days after the first follow-up survey.

c. During these surveys **no mass radical** treatment is to be given. Only presumptive treatment shall be given.

d. Strengthen the case detection operations and ensure fortnightly visits to all villages.

e. Activate all FTDs and Link Workers.

f. Investigate cause of epidemic by an epidemiological investigation to find out whether the epidemic was due to :-

i. Influx of migratory population which was not covered by routine control measures such as screening at the entry points and regular fortnightly surveillance in the project areas

ii. Whether it was due to breakdown of regular malaria control operations.

iii. In some instances unusual **natural calamities** such as floods, heavy rains, drought with opening up of relief camps and other temporary relief measures with temporary shelters for migratory population may be responsible for an epidemic and disruption of operations

8. Detailed Planning of epidemic control measures

Proforma - II

Mass Survey - Period: Seven days

1. Manpower requirements

$$\frac{\text{Population}}{100 \times 7} \times 2 = \text{No. of persons required for B.S. collection and administration of Presumptive Treatment.}$$

(It is expected that two member team can collect 100 blood smears per day).

If the mass survey cannot be completed in Seven days, it can be extended by another three days. Any further delay will result in extension of epidemic zone and deaths.

2. Material Required

a. 4-aminoquinolines - Population x 3 (in terms of 150 mg base tab.)

b. Primaquine - Populations x 18 (in terms of 2.5 mg base tab.)

c. Microslides - Population X 1

d. No of microscopists required - $\frac{\text{Population}}{50 \times 7}$

e. No. of microscopes required - one per microscopist

f. Cotton, Spirit/Savalon, Slide boxes, Pricking needles, Stationery, etc. to be procured on ad-hoc basis.

g. J.S.B. Stain as required. Other material for cleaning and packing of slides etc. can be estimated on ad-hoc basis.

operations and **iii.** antilarval measures in special situations.

i. Case Detection, Treatment and Management

The monitoring of detection, treatment and management of malaria cases comprises of active case detection, passive case detection and management of severe & complicated malaria cases through referral services. The Medical Officer of PHC is mainly concerned with monitoring of case detection activities which are under his direct supervision. He should look into early case diagnosis and prompt treatment (EDPT) of all malaria cases in his jurisdiction. Each component involved in the case detection should be constantly and thoroughly monitored so that prompt corrective measures are undertaken whenever the breakdown of services is detected.

The case detection in every village is carried out by the active case detection agencies like Multipurpose Workers and Health Supervisors. Passive case detection is also conducted by institutions providing health care facilities such as PHC laboratory, Malaria Clinics, Hospitals, Dispensaries, Private Practitioners, Voluntary agencies like Fever Treatment Depots, Drugs Distribution Centres, Voluntary Link Worker. While monitoring the above activities, it is essential to look into all factors responsible for interruption in the availability of services to the community.

Active Case Detection (ACD)

ACD envisages fortnightly domiciliary visits for collection of blood smears from all fever cases and cases with past history of fever that may have occurred between the consecutive visits and administration of presumptive treatment. MPW (Male) is actively associated with ACD. The Medical Officer of PHC should check the following aspects:-

Population Record

Calendar of Domiciliary Visits

Every year the calendar of activities is prepared depicting fortnightly visit in each Subcentre. Again the PHC Medical Officer/DMO should ensure that the schedule is followed by the MPW. Copy of the fortnightly visit schedule of all the Subcentres should be maintained at the PHC level so that whenever the Medical Officer of the PHC goes on field visit, he can verify the compliance of domiciliary visit by the MPW (Male).

Frequency of House Visit

The frequency of house visit made by the MPW should be confirmed. In case any domiciliary visit cycle is missed, the reason should be ascertained whether it is due to vacancy in the MPW cadre or MPW on leave or due to sheer negligence of the MPW. It may also be possible that in different areas, MPW may not be able to cover the entire area of the Subcentre within the specified schedule.

Corrective measures should be taken according to the deficiencies observed so as to implement regular frequency of house visit.

Population Coverage and Blood Smear Collection

Apart from frequency of domiciliary visits, it is necessary to see that the population is actually covered during fortnightly visit for surveillance activities. This can be done by physical verification in the area by discreet enquiries from the head of the families/family members. It can also be ascertained by entries in MF-1 i.e. family register and MF-2, whether the MPW has gone to the household, enquired about fever and what entry he has made in the relevant column.

The entries in MF-1 can be cross-tallied with the entries in MF-2 to verify the accuracy of such entries. Lastly the entries in MF-9 should also be cross-checked with entries in MF-1 and MF-2. It is not necessary to carry out these activities every fortnight, but such a cross-checking may be done by the PHC Medical Officer/DMO during the transmission period, when any change in the fever frequency in the community could be observed.

Some of the reasons for low collection of blood smears may be due to negligence of the MPW (Male) and his gross dereliction of duty. It may also be influenced by the status of community acceptance of the worker. This is more aptly applicable to FTDs and DDCs. Another aspect given

importance is coverage of specific population groups such as young children, pregnant women and migratory population requiring close monitoring. The infants, children and pregnant women constitute the vulnerable group. While scrutinizing the record, it may be observed that their blood slides have been collected and such collection is not significantly lower than the other age groups and sex.

Passive Case Detection (PCD)

Passive case detection is equally important component of antiparasitic measures. The ratio of blood smears between ACD and PCD should be continuously monitored every month and corrective measures should be undertaken, if there is a marked deviation from the norms recommended by NMEP and also compare the ratio with the preceding months. Since the blood smears are collected from current fever cases in PCD, the slide positivity rate is usually much higher in PCD blood smears as compared to ACD blood smears. Therefore priority for microscopic examination should be given to PCD blood smears. It is important that the blood smears collected in every clinic, dispensary, hospital, private practitioner, etc. are referred to laboratory for early microscopic examination. The quality of blood smears collected and proper staining are important for correct diagnosis. The MO-PHC should ensure that good quality microslides are replenished frequently and adequately. The supervision on staining, stain preparation and laboratory maintenance will improve the case detection mechanism.

Prompt Treatment

The correct dosage as per the age groups for presumptive and radical treatment can be monitored from entries made in MF-2. During field visit, the number of tablets administered should be randomly checked through discreet enquiry from the treated cases.

The presumptive treatment schedule as per age groups should be strictly monitored. It should be ensured that the fever cases consume the antimalarials in the presence of the drug dispensers. This could be verified through discreet enquiry. The Revised National Antimalarials Drug Policy - 1995 should be strictly adhered to. The presumptive treatment schedule in high risk areas being different i.e. 1,500 mg of Chloroquine total adult dose to be administered in three divided doses of 600 mg along with 45 mg Primaquine on day 1, 600 mg Chloroquine on day 2 and 300 mg Chloroquine on day 3. Complete treatment is to be given even if the fever subsides. The cases with history of fever also are to be treated similarly. The three day therapy is to be followed from PHC up to Subcentre level only. The FTD, DDC and VLW will administer one day treatment of 600 mg Chloroquine adult dose only. Constant monitory will ensure implementation of revised drug policy correctly.

In Chloroquine resistant *P.falciparum* areas, the presumptive treatment is different at DDC/FTD level where one day Chloroquine treatment is followed while MPW follows three day treatment as cited above. The presumptive treatment at PCD, PHC Medical Officer and OPD comprises of second line of treatment with enhanced dose of long acting Sulfa+Pyrimethamine (i.e. 1500 mg Sulfa+75 mg Pyrimethamine as adult dose) as recommended by the Expert Committee of Revised National Antimalaria Drug Policy - 1995. The Medical officer must be very thorough with the complex dosage schedules at different levels. It should be monitored that the concerned functionary carries with him the chart showing the age-wise dosage schedule recommended in the area to be administered by the particular functionary.

Similar methodology should also be followed for monitoring radical treatment schedule. The radical treatment records of all agencies should be monitored and stock register to be verified as against the cases treated.

Some Important Aspects of Monitoring For Implementing EDPT

- Time lag between date of collection of slide and its receipt in the laboratory.

- Time lag between receipt of the blood smear in the laboratory and its staining.

- Time lag between receipt in the laboratory and its examination.

- Time lag between communication of results from the laboratory to periphery and administration of radical treatment.

- Total period from blood smear collection to radical treatment.

- The frequency of house visits missed by the MPW and reasons thereto shall be monitored for instituting corrective measures. Alternative arrangements will have to be improvised in case of leave vacancy or inaccessibility of the area during monsoon, etc. Dereliction of duty by peripheral workers should be instantly corrected.

Referral Services

One of the major objectives of the programme is prevention of deaths due to complicated and severe malaria. The peripheral worker, FTD/ DDC holders and VLW should be properly trained regarding the identification of complicated and severe cases of malaria and refer the cases immediately to referral centre without time lag after administering the presumptive treatment. The Medical Officer must be highly vigilant in the monitoring of such cases in the area so as to prevent mortality on account of malaria. All essential facilities for management of severe and complicated cases at referral centre must be maintained round the clock to meet any emergency.

ii. Indoor Residual Insecticidal Spray Operations

The Expert Committee on Malaria - 1995 has recommended that the high risk villages will have to be identified by the Medical Officers as per the criteria laid down which are based on the data pertaining to the preceding three years. The Operational Manual on Malaria Action Programme - 1995 has highlighted the guidelines for selection of high risk villages by MO-PHC. Having selected the villages, the MO-PHC must ensure that the insecticidal spraying in the target villages is completed within the scheduled dates. The concurrent monitoring will enable the supervisory officials on the quality of spray coverage, number of houses and rooms actually sprayed as against the target and whether the poor coverage is due to lack of persuasion by the spray teams or persistent refusal by the community. Concurrent monitoring will be helpful in instituting timely corrective measures. Mopping of spray operations will have to be undertaken through IEC, wherever required. The correct dosage and quality of spray could be checked through concurrent and consecutive monitoring of records and through field visits. For many control activities, there may not be any alternative to direct supervision by regular and random surprise checking. It should be ensured that cattle sheds are not sprayed but human dwellings and mixed dwellings are sprayed.

It is not sufficient only to ensure good coverage with correct dosage within the scheduled dates, but it is also equally important that inmates sleep indoors of sprayed rooms during the transmission season and also that the sprayed walls are not mud plastered within the period of residual efficacy of insecticide. All these components are to be included in the monitoring of indoor insecticidal spray.

iii. Antilarval Measures

In special situation in rural areas where *An.stephensi* is vector or where residual insecticidal spray does not make a dent on the transmission, antilarval operations will constitute as alternative or supplementary method. The frequency, dosage and coverage of all target breeding places will have to be monitored for successful control operations. The pre and post-spray larval checking should be regularly monitored.

B. LOGISTIC FLOW

Logistics constitute the backbone for the control operations of any national health programme.

The material and equipments shall have to be indented as per time schedule and dumping of material at the identified villages should be completed before commencement of spray. The spray equipment shall be checked well in time to undertake repairs, if needed. In case of shortage of material like drugs, microslides, pricking needles, chemicals, etc. requisition to the higher authorities for supplies will be feasible only by

regular monitoring of logistics. The States will have to send the proposal to the Centre for procurement of material and equipment based on epidemiological data of previous year(s). For example the requirement of material for 1998 shall be sent to the Directorate of NMEP in January/ February 1997 based on epidemiological data of 1995 or 1996. The same is applicable for material and equipment directly procured by the States. While working out the requirement, the stocks in the pipeline should also be taken into consideration.

C. FINANCIAL FLOW

In the past the spray operations were often disrupted due to non-payment of wages to spray men. The State and District authorities must provide funds for payment of wages to casual labourers, undertaking repairs for equipment, meet expenses for POL and local purchases. The officers should judiciously use the funds for maximum output. Regular monitoring holds the key for enabling timely financial flow from programme headquarters to the periphery.

Proformae for Monitoring Malaria Control Measures in Rural Areas

1. MF- 1: Family Health Register indicating the details of family members.
2. MF- 2: A register to be maintained by the peripheral worker for reporting of blood smears collected along with details of the fever cases.
3. MF- 3: Relates to information regarding the monthly tours of surveillance inspectors/health supervisors/malaria inspectors and surveillance workers/MPWs.
4. MF- 3A: Tour Journal cum work statement of MPW/SW of Subcentre.
5. MF- 4: Monthly report of PHCs/District Malaria Officers regarding B.S. Collection, Examination, etc.
6. MF- 5: Remedial measures against positive cases.
7. MF- 6: Regarding spray operations (MF- 4 to 6 are sent by the District Malaria Officer every month in the technical report to the State Malariologist with a copy to Dte. of National Malaria Eradication Programme).
8. MF- 7 to 9: These have been devised for maintaining records in the PHC Laboratory.
11. MF- 10: Monthly passive agencies report.
12. MF- 11: Weekly savingram from the PHC to the DMO furnishing details of B.S. Examined and found positive.
13. MF- 12 to 15: Tour report of District Malaria Officer, District Medical & Health Officer, Zonal Officer, etc.
17. MF- 16: Report on Drug Distribution Centres and Malaria Clinics.
18. : Consolidated District-wise Monthly Epidemiological data by the State.
19. : Proformae for recording death due to malaria : Monthly report by the State.

For detailed instructions on how to fill the forms and when to send them to the concerned authorities, consult Annexure- 6.1.

Monitoring Under Urban Malaria Scheme (UMS)

The Urban Malaria Scheme is in operation in 131 towns/cities in the country. The main activities under the UMS are:-

i. Case detection and treatment through PCD.

ii. Recurrent antilarval measures with approved chemical larvicides and bioenvironmental control measures including minor engineering works.

iii. Water management by providing appropriate water supply and disposal.

iv. Improvement of storm water drainage.

v. Source reduction of peri-domestic water bodies by drainage and filling in urban and semi-urban areas.

vi. Indoor space spray with pyrethrum in and around 50 houses where malaria positive case is detected.

vii. Strict implementation of civic bye-laws for prevention/elimination of domestic and peri-domestic breeding places.

The Officer incharge of UMS shall review the programme regularly and submit the monthly technical reports to District Malaria Officer and endorse copies to Directorate of Health Services, Regional Director for Health and Family Welfare and Director, NMEP, Delhi.

The regular monitoring is done by reviewing various facets of the scheme as given in the following proformae.

UM Proforma-I

Larvicidal treatment of mosquito breeding places with chemicals such as MLO, Fenthion, Temephos, Paris green, etc. The opening balance, quantity consumed and balance at the end of the month.

UM Proforma-II

Larval and Pupal density checking before and after larviciding.

UM Proforma-III

Particulars regarding consumption of pyrethrum extract and malaria incidence during the month.

UM Proforma-IV

Adult vector densities in fixed and random catching stations.

UM Proforma-V

Particulars regarding material & equipments and staff vacancy.

UM Proforma-VI

Cross-checking of breeding places and remedial measures.

UM Proforma-VII

Monthly Mosquito Density proforma (concised).

UM Proforma-VIII

Staff position and expenditure.

The proformae for UMS are given in Annexure- 6.2.

The Expert Committee on Malaria - 1995 identified 15 major cities and 14 other towns in the country where urban situation is serious. The Officers incharge of these towns should undertake accelerated urban malaria scheme through active case detection by establishment of fortnightly/ domiciliary visit in slum areas, strengthening of Passive Case Detection in hospitals and dispensaries by providing a malaria worker to collect blood smears from OPD fever cases. All fever cases from whom the blood smears are collected are to be given presumptive treatment with appropriate antimalarials. The blood smears should be examined expeditiously for giving radical treatment. The UMS Officer should ensure regular monitoring and undertaking corrective measures.

Monitoring at District Level

Under the Modified Plan of Operation, a post of

District Malaria Officer was created in every endemic district.

The DMO monitors the malaria situation in both rural and urban areas. The indoor residual spray in rural areas is a vertical component of the programme under the direct responsibility of DMO. He carries these activities through the support of Primary Health Care System and Medical Officers of PHCs take active part in the monitoring of spray operations in their respective areas besides other antimalaria activities.

Based on the list of high risk villages identified by PHC-Medical Officers, the DMO prepares the priority list of villages to be covered under indoor insecticidal spray. He has to monitor the availability of adequate quantity of insecticide in each dumping station and shifting the balance insecticides for use in other areas before the expiry date. He has also to monitor that the insecticide meets the standards laid down by ISI till the end of shelf life period and gets the field samples tested in the recognised quality control laboratories when the quality such as suspension of insecticide is found inferior.

The DMO monitors the programme regularly and submits the report in the prescribed proformae to the Director of Health Services with copies endorsed to ROH & FW and Director, NMEP, Delhi.

Monitoring at Zonal Level

The Zonal Officers shall monitor the data by displaying administrative, epidemiological and operational aspects pertaining to the districts under their jurisdiction. The tour days including night halts by DMO, villages visited, malaria positive cases checked, etc. should be covered under monitoring by the zonal officer. The month-wise blood smear collection, examination, positives detected and remedial measures undertaken shall be separately monitored in respect of each district. PHC-wise positive malaria cases based on savingrams are to be consolidated at the zonal level. The Zonal Officer has a special component of Zonal Entomological Team which shall monitor the vector densities, susceptibility status of vectors to the insecticides/larvicides, vector incrimination, bionomics, etc. and correlation of entomological data with epidemiological parameters. He will also oversee the cross-checking of control operations in all villages and towns under his jurisdiction. The proformae for Entomological monitoring at Zonal Level are given in Annexure- 6.3.

Monitoring at Regional Level

The Govt. of India has established 17 Regional Offices (ROH & FWs) in different parts of the country to coordinate Health & FW activities including NMEP in the States. In major States, one ROH & FW coordinates the programme for one State while in smaller States/UTs, one ROH & FW coordinates the programme for 3 to 4 States/UTs.

Besides Medical component, 16 ROH & FWs have entomology component with Assistant Director (Ent) and supportive technical staff to monitor the programme. The Officers and technical staff make regular field visits to monitor the programme pertaining to epidemiological and entomological aspects. The blood smears are cross-checked at the laboratories of ROH & FW to improve the case detection mechanism.

The Regional Director reviews the programme regularly. In consultation with the State Malariologist he renders technical advice for change of insecticide wherever needed.

In addition to above, 12 ROH&FWs also monitor the sensitivity of *P.falciparum* to Chloroquine and other antimalarials.

Monitoring at State Level

The State Programme Officer is the technical head for the NMEP operations in his State under the Director of Health Services. He reviews the epidemiological situation in the State. He keeps strict watch on the tour of DMO and other officers.

The State Programme Officer monitors the following aspects:

i. Consolidated district-wise monthly technical reports received for PHCs on MF-4, MF-5 and MF-6 and total data for the State.

ii. Monthly reports indicating the vacant posts category-wise and district-wise.

iii. Monthly Expenditure report under different sub-heads of the State.

iv. Monthly reports on the number of DDCs/FTDs, Malaria Clinics established and number of cases attended (MF-16).

v. Cross-checking of blood smears to improve diagnosis.

The tour reports of District Malaria Officer (MF-12) and Zonal Officer (MF-15) are reviewed by the State Malariologist and he sends necessary guidelines for remedial measures.

Monitoring at National Level

The Directorate of NMEP has an in-built Assessment Section which monitors the programme regularly. The technical advice is regularly given by the Directorate of NMEP on the monthly technical reports received from the State. The Officers of NMEP make periodic field visits to monitor the programme and also for investigating epidemics so as to undertake immediate containment measures. The state-wise and country-wise malaria situation is regularly monitored. Micro-analysis of data is being done for identification of high risk areas for accelerating the malaria action programme. A separate section in the Directorate monitors implementation of Urban Malaria Scheme. Chloroquine resistant status of *P.falciparum* is regularly monitored through 13 *P.falciparum* Monitoring Teams in the country.

Monitoring of Impact of Control Measures

The monitoring of impact of control measures should be a continuous process for each activity. The observations are to be analysed which shall be based on factual data and not impression through cursory glance. The activities to be covered can be broadly divided into the following functions:-

I. Early Case Detection

The frequency of house visits and cycles missed should be closely monitored to ascertain the reasons for missing the domiciliary visits. If the community acceptance is poor, IEC intensification should be taken up with the help of opinion leaders, panchayat members, teachers, local traditional medical practitioners, missionaries, etc. The blood smear collection should cover all age groups, both sexes and vulnerable groups. The quality of blood smear, if found inferior, should be improved through corrective measures.

II. Chemotherapy

a. Presumptive Treatment

The correct dosage of antimalarials as per age should be ensured for different areas i.e. high risk, low risk and *Pf.* resistant areas by different levels of workers as recommended by the Expert Committee on Revised National Antimalaria Drug Policy - 1995.

b. Radical Treatment

All positive cases shall receive radical treatment as per recommended doses within 48 hours of blood smear examination. It should also be ensured that the radical treatment is administered by the concerned paramedical staff.

It should be monitored that Primaquine is not administered to pregnant women and infants either in presumptive or radical treatment.

c. Referral Services for Severe and Complicated Fever Cases

In case the fever does not show remission within 48 hours of presumptive treatment and is associated with severe symptoms, the peripheral worker shall promptly refer the case to the nearest referral centre. The monitoring should be intensified to prevent death due to malaria. Establishment of referral centres should be augmented in high risk areas.

III. Indoor Residual Insecticidal Spray Operations

a. Spray Schedule

The indoor insecticidal spray operations should be carried out as per the schedule dates. If the operations are delayed, the reasons for the same should be investigated and rectified. The coverage of rooms shall not be less than 80%. In case of low coverage, the bottlenecks for the same should be removed and mopping up operations should

undertaken after intensifying community health education. The dosage and uniformity of spray should be checked for undertaking corrective steps. The supply position, the maintenance of spray equipments with adequate number of spare nozzle tips, prompt payment of wages to the temporary spray staff, etc. should be effectively monitored for improvement of spray coverage through active community cooperation.

It should be ensured that cattle sheds are not sprayed but human dwellings and mixed dwellings are sprayed.

IV. Parameters to be Monitored

Absolute numbers are not dependable for comparison of trends in malaria incidence. The parameters are to be calculated to compare the data for different areas at the same time or same area at different points of time. The following epidemiological and entomological parameters are to be monitored regularly.

A. Epidemiological Parameters

Parameters during Epidemiological Survey

i. Infant Parasite Rate (IPR)

ii. Child Parasite Rate (CPR)

iii. Child Spleen Rate (CSR)

iv. Average Enlarged Spleen (AES) index

The above parameters are collected during epidemiological survey.

Parameters during Eradication

i. Annual Blood Smear Examination Rate (ABER)

ii. Monthly Blood Smear Examination Rate (MBER)

iii. Slide Positivity Rate (SPR)

iv. Slide falciparum Rate (SfR)

v. Annual Parasite Incidence (API)

vi. Annual falciparum Incidence (AfI)

vii. *P.falciparum* percentage (*Pf%*)

B. Parameters for Spray Operations

i. % of Villages covered

ii. % of Houses sprayed

iii. % of Rooms sprayed

C. Insecticide Used

i. Average quantity consumed per house

ii. Average quantity consumed per room

iii. Quantity consumed per unit population

D. Entomological Parameters

i. Per man-hour density of adult mosquitoes (human dwellings/cattle sheds/outdoor).

ii. Pyrethrum spray collection

iii. Bait collection (human/animal)

iv. Larval density

v. Infection and infectivity rates

vi. Abdominal condition (unfed/fully fed/half gravid/full gravid).

vii. Parity Rate (nalliparous/parous - one parous, two parous, three parous, etc.).

ASSESSMENT

Assessment is done periodically depending upon the magnitude and transmission dynamics of the problem as well as the objectives of the programme. In a programme like control of filariasis, assessment is done at an interval of 5-10 years because of low incidence , long incubation interval, prolonged patency and irreversible chronic manifestations. The assessment of malaria control measures is done at yearly or two yearly interval, because of fast changes in the incidence from year to year.

The main purpose of undertaking regular assessment is to see how far the objectives of the programme have been achieved and analyse the reasons or bottlenecks hindering full realisation of the objectives.

The assessment is carried out by the experts in the disease control who are not directly connected with the programme implementation. The experts are drawn from Medical Faculty having specialisation in public health, bio-medical scientists, sociologists, bio-statisticians, administrative managers, finance & expenditure managers, media experts, etc. The experts directly involved in the programme implementation serve as resource persons only, so as to apprise the team of the assessment experts with all the relevant information.

The periodic assessment of the programme covers the following aspects:-

i. The epidemiological and entomological parameters are calculated for at least two years.

ii. The parameters are compared to observe the trends. The parameters are also collected month-wise so as to delimit the period and peak(s) of transmission. The monthly trends are also compared with same months of the preceding years.

iii. The achievements in the morbidity, mortality, proportion of *P.falciparum* cases, etc, are compared against the targets set for the year.

iv. The achievements of the programme in different spheres are also compared. The collateral benefits of the programme are assessed to measure the impact on other vector borne diseases.

v. The bottlenecks that are responsible for failure in achieving the set targets are identified. The reasons for not achieving the targets shall cover all aspects pertaining to a) Technical b) Organisational c) Financial and d) Administrative spheres.

vi. The solutions to overcome the hurdles in the implementation of the programme are suggested and recommendations for modifications in the control strategy are made.

Annexure- 6.1

M.F. - 1

FAMILY HEALTH REGISTER

House No. ____________________

Name of PHC ____________________

Area/Village(Locality) ____________________

District ____________________ State ____________

Sl.No.	Name of the family member	Name of the Head of Family	Whether usual resident (Yes/No)	Age with Sex (Date of birth if possible)	Marital Status	Education	Occupation	Annual Income (in Rs.)	Number of living children M/F
1	2	3	4	5	6	7	8	9	10

Instructions For Filling Up Of Family Health Register

Col. 1 : This should be running number starting from(1) for each family separately.

Col. 2 : Name of all the members of the family should be given in this column. Casual members may also be shown in this column, if they stay for long.

Col. 3 : Head of the family shall be the same for casual members also. Relationship of the members shown in column (2) should be mentioned here likewise.

Col. 4 : Nature of stay of member may be shown here.In case of wife, son, daughter, etc., it will be a permanent stay and in case any other relation stays for sometime, it will be called as temporary stay.

Col. 5 : The age of each member should be entered in complete years against his/her name. As far as possible the date of birth of the member may also be recorded against his/her name.

M.F. - 2

FOR REPORTING OF BLOOD SMEARS BY SURVEILLANCE WORKER / MULTIPURPOSE WORKER / PASSIVE AGENCY / MI

NAME OF SUBCENTRE : ____________________

HEADQUARTERS : ____________________

POPULATION : ____________________

CODE NUMBER : ____________________

NAME OF THE PHC: ____________

Village	No. of the house	Name of Head of family	Name of patient/ person	Age & Sex	Sr.No. of blood smear	Treatment No. of tablets given (4-amino)	Date of Collection	RESULTS					If +ve. Progressive case No
								P.f.		P.v.	P.m.	Mixed indicate stage	
								R	RG				
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Note: This Proforma should be in triplicate and three copies forwarded to PHC Laboratory Technician who will retain one copy and send the other two to the Surveillance Inspector/Malaria Inspector.

Signature of Microscopist   Date of examination by the Microscopist   Signature of Surveillance Worker/MPW/SI/MI/Passive agency

M.F. 3

TOUR JOURNAL CUM WORK STATEMENT OF SURVEILLANCE INSPECTOR / BASIC HEALTH INSPECTOR / MALARIA INSPECTOR

PHC.:- ________________ Name of the Inspector :- ________________ Month :- ________________

Date	Village visited	Sub-centre	Group No.	If Con-current contacted MPW/SW	If Con-secutive missing visits of MPW/SW	No. of Positives grouped for RT (PC No.)	No. RT given	B.S. Collected from fever cases	B.S. Collected		B.S. Follow up +ve cases	B.S. Total	Antimalarials used		No. of passive agencies, FTDs contacted	Focal spray		Community therapeutic measures (MST) if done - No.
									Mass	Cont-act			4 A.Q.	8 A.Q.		Rooms	Cattle* Sheds	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

* Cattle Sheds are not to be sprayed as per the Expert Committee Report on Malaria-1995.

M.F. 3-A

TOUR JOURNAL CUM WORK STATEMENT OF MULTIPURPOSE WORKER/SURVEILLANCE WORKER OF SUBCENTRE

FOR THE MONTH OF ________________

NAME OF THE SUBCENTRE ________________ NAME OF THE PHC:- ________________

HEADQUARTERS :- ________________

POPULATION ________________ CODE NO. :- ________________

Date	Group No.	Village visited	No. of families		Population		No of fever cases treated without B.S.	No. of B.S collected	Tablets used 4 AQ.	R.T. done P.C. No.	Tabs. used 8 AQ	Date of despat-ching of B.S.	Passive agency FTDs Panchayats/ teachers contacted	No. of drugs given 4AQ
			Allotted	Visited	Allotted	Visited								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Month's Total														

Balance Stock in Hand

a) Chloroquine:- ....
b) Sulpha + Pyri :- ....
c) Primaquine:- ....
d) Amodiaquine:- ....
e) Glass sildes.- ....
f) Service stamps:- ....

Certified that I visited all the famillies & entries in my diary are true

Signature of MPW/SW

M.F - 4

MONTHLY REPORT OF MALARIA PROGRAMME OF PRIMARY HEALTH CENTRE

Name of the State:- ______________________

Name of the Distt:- ______________________

Total Population:- ______________________

Sl.No.	Name of PHC/ Sub-centre	Type of malaria paradigm	Total Pop.	ACTIVE Blood Slides			MASS & CONTACT Blood Slides			PASSIVE Blood Slides			TOTAL Blood Slides			AGEWISE POSTIVES				RT Done				Death due to mal.	
				Coll-ected	Exam-ined	Posi-tive	Coll-ected	Exam-ined	Posi-tive	Coll-ected	Exam-ined	Posi-tive	Coll-ected	Exam-ined	Posi-tive	Under 1 Yr.	1-4	5-15	15+	Under 1 Yr.	1-4	5-15	15+	Pf micro-scopically confirmed	only clinically diagnosed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
TOTAL																									

N.B. : The entries in col. 25 are not to be repeated in col. 26

M.F. - 5

MONTHLY REPORT OF MALARIA PROGRAMME OF PRIMARY HEALTH CENTRE

Name of the State:- ______________________

Name of the Distt:- ______________________

Sl.No.	Name of PHC	NO. POSITIVE			SPECIES					R.T. Given	Total focal spray of rooms	Total fever cases treated with 4-AQ tabs. single dose w/o B.S	Mass therapeutic measures				Balance Tablets			
		Male	Female	Total	Pv	Pf		Oth-ers	Total				Single dose 4-A.Q.+ 8-A.Q. 600+45 mg mg	Single dose Sulpha + Pyri	R.T. 5 days	Total	4-AQ	8-AQ	Sulpha + Pyri	Quin-ine
						R	RG													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
TOTAL																				

M.F. 6

MONTHLY REPORT OF MALARIA PROGRAMME
(PROGRESS & ASSESSMENT OF SPRAYING)

Name of the State :- ____________

Name of the District:- ____________

Name of the Malaria Inspector:- ____________

Headquarters:- ____________

Name of the PHC selected for Spray ____________

Total Subcentres ____________

Population:- ____________

Sl. No.	Name of Sub-centre	Population	Insecticide used	Period of spraying rounds	Targeted Rooms	Achievements		Balance of Insecticide in M.Tons			
						No. Sprayed	Coverage in%	D.D.T. 50% wp	B.H.C. 50% wp	Malathion 25% wp	Synthetic Pyrethroids (Specify)
1	2	3	4	5	6	7	8	9	10	11	12
A.	Sprayed Subcentres										
1.			1st Rd								
			2nd Rd								
			3rd Rd								
2.			1st Rd								
			2nd Rd								
			3rd Rd								
3.			1st Rd								
			2nd Rd								
			3rd Rd								
B.	Non-sprayed Subcentres										
Total											

M.F. 7

DETAILS OF POSITIVES AND REMEDIAL MEASURES

Subcentre:- ____________

District/PHC ____________

Population:- ____________

Code No.:- ____________

Sl.No.	P.C. No.	Source	Group No.	Vill-age	Name of Head of family	Name of Patient	Age	Sex	Code B.S. No	Date of Collec-tion	Date of exam-ination	Spec-ies	Date of receipt of results by MPW	Radical Treatment		If died—date of death and species
														From	To	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

B.S. Collected				FOCAL SPRAY				TIMELAG BETWEEN		Follow - up smear number and date
Contact		Mass								
No	Result	No	Result	Date	Targeted Rooms	Sprayed Rooms	% of coverage Rooms	Collection & R.T	Collection and focal1 spray	
18	19	20	21	22	23	24	25	26	27	28

M.F. 8

REGISTER OF BLOOD SMEARS RECEIVED & EXAMINED (SUBCENTRE-WISE)

Name of Subcentre:- ____________________ Name of PHC :- ____________________

Population:- ____________________ Year :- ____________________

Code No.:- ____________________

Date of rece-ipt	Name of MPW or other agency including FTD etc.	Fever treated w/o B.S. M.S.T. done	Active (A)			Passive (P) FTD			MASS & Contact (M&C)			Period of collection	Date of exami-nation	*Number of B.S. Examined-Postive			POSITIVE SPECIES					SL. No. of positive cases	Date of despatch of report
			Sl. No.		Total B.S.	Sl. No.		Total B.S.	Sl. No.		Total B.S.			A	P	M&C	Pv	Pf		Pm	Mixed		
			From	To		From	To		From	To								R	RG				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Total for the Week																							

*In col. no. 15, 16, 17 - the no. of B.S. examined from Active (A), Passive (P) and Mass & Contact (M&C) are posted. Below these the positives among them are posted in a circle.

M.F. 9

EPIDEMIOLOGICAL EVALUATION MASTER REGISTER (SUBCENTRE-WISE, VILLAGE-WISE & MONTH-WISE)

Name of State:- ____________________ Name of Subcentre:- ____________________

Name of Distt:- ____________________ Code No.:- ____________________

Name of PHC:- ____________________

JANUARY*

Sl. No.	Name of Village	Popul-ation	Target B.S.	Fort-night	B.S. Active	AGENCY-WISE, SEX-WISE POSITIVE								AGE-WISE POSITIVE								P.f. rings only	TOTAL Positive	A.P.I.
						ACTIVE		PASSIVE		MASS & CONTACT		Total		P.f. & MIXED				Pv. & OTHERS						
						Male	Female	Male	Female	Male	Female	Male	Female	Under 1-yr.	1 - 4	5 - 14	15+	Under 1-yr	1-4	5-14	15+			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	A			1																				
				2																				
2	B			1																				
				2																				
Total for the month (Blue ink) (Monthly Report)																								
Total in the next month (Red ink) (Supplementary report)																								

*Separate page for each month from columns 5-23 though the list of villages remains common on first page.

M.F.-10

PASSIVE AGENCIES INCLUDING FEVER TREATMENT DEPOTS REPORT

Name of PHC: ______________________ For the month of ______________________

Sl.No.	Name of agency / FTD	OPD-New cases	No. of fever cases	Fever cases treated with 4-AQ without B.S.	B.S. Collected	Number positive	4 - AQ consumed	Number R.T. given	8 - AQ consumed	Balance of drug	
										4-AQ	8-AQ
1	2	3	4	5	6	7	8	9	10	11	12

Note: FTD will fill up column 5 to 8 and 11

M.F.11

SAVINGRAM FROM PRIMARY HEALTH CENTRE

Name Of PHC: ______________________

Population ______________________

Sl. No.	Name of the Subcentre	Fever treated	B.S. Collected	Positives	SPECIES					Backlog Smears
					Pv	Pf		Pm	Mixed	
						R	RG			
1	2	3	4	5	6	7	8	9	10	11

MEDICAL OFFICER

Copy forwarded to:

1. Zonal Officer (Malaria)
2. Distt. Malaria Officer
3. Malaria Inspector

M.F. - 12

TOUR REPORT OF DISTRICT MALARIA OFFICER

For the month of ______________________ Name of PHC ______________

A. GENERAL

1. Name of the District
2. Name of the Officer
3. Period since when he is working in the present district.
4. Name of the month to which the report relates.

B. TOUR PARTICULARS

1. Total number of tour days
2. Total number of night halts made outside headquarters
3. Number of workers whose work is inspected concurrently (Give Subcentre names)

C. SURVEILLANCE UNDER ACTIVE:

	Within 1.5 km (one mile) from road	Within 1.5 to 4.5 kms (1-3 miles) from road	Over 4.5 kms (three miles) from road
1. Number of Villages where surveillance is inspected			
a) Consecutively :			
b) Concurrently:			

2. Number of houses inspected ______________________________
3. Average collection of Blood smears per worker during the previous month (———19--in the PHC)
4. Number of workers on whom memos were earlier given for inadequate collection and the level of improvement.
5. Number of workers on whom disciplinary action taken by way of
   i) Cutting of F.T.A.or M.T.A.
   ii) Removal from service.
6. Number of surveillance inspectors whose work is inspected.
7. Whether tour report of S.I. received for the month.

D. SURVEILLANCE UNDER PASSIVE

1. Number of passive agencies including FTDs in the PHC.

2. Number from whom reports received.
3. Action taken on those who have not furnished the reports
4. Number of agencies where blood smear collection is more than 15% of all the cases treated.
5. Action taken on the others
6. Number of passive agencies contacted

E. SPRAYING	Within 1.5 km (one mile) from road	Within 1.5 to 4.5 kms (1-3 miles) from road	Over 4.5 kms (three miles) from road
1. No. of villages inspected for focal spraying			
2. No.of villages inspected for regular spraying and percentage of coverage			
3. Steps taken to have full spray staff in position.			

F. LABORATORY : PHC

1. Whether register MF-8 maintained, if not, what action taken to improve.
2. Whether epidemiolgical evaluation register MF-9 up to date, if not, what steps taken
3. Whether charts are maintained, if not, what action taken to improve
4. Number of cross-check variations received from State lab. & ROH & FW lab. during the month
5. Remedial measures taken for cross-check of positives

G. REMEDIAL MEASURES

1. Number of positives detected in the PHC during the month
2. Number of positives investigated and verified himself
3. Number of cases where remedial measures were inspected and verified.

H. PERIODICALS

1. Monthly technical report received from the PHC and if not, what steps taken
2. Is savingram epidemiological situation being sent regularly ?

I. PEOPLE'S PARTICIPATION

Panchayats, teachers, youth organistations, etc.

Whether account of drug received alongwith the report, if not, what steps taken.

J. ANTIMALARIALS

Quantity of drugs issued to PHC are checked vis-a-vis B.S collected and fever treated, and deficiency detected, measures taken

K. GENERAL

Brief highlights of important events in the PHC.
Any subcentre showing abnormal rise in cases-
Reasons and action taken

DISTRICT MALARIA OFFICER

M.F. 13

MONTHLY REPORT OF NMEP WORK DONE BY DISTRICT MEDICAL AND HEALTH OFFICER

1. Name of the District
2. Name of the month to which the report relates
3. Particulars of Passive Surveillance in medical Institutions visited by DM & HO during the month

Sl.No.	Name of Institution	Total new cases treated during the year from Jan. up to date of visit	Total B.S. collected during the year from Jan. up to date of visit	Action taken for collection of less than 15% of the new cases treated in OPD	Whether subcentre FHW/ ANM involved in B.S. collection and R.T.
(1)	(2)	(3)	(4)	(5)	(6)

DISTT. MEDICAL & HEALTH OFFICER

The same proforma may be used by Dy. CMO(H)

M.F.-14

PARTICULARS OF PRIMARY HEALTH CENTRE VISITED

Sl.No.	Name of PHC	No.of MPWs	B.S. collection by the MPWs from the beginning of the year up to date of visit	Average collection per worker per month	Positives recorded during the year	Number to which R.T. given	Whether cross -check smears are sent to State lab. and ROH & FW lab regularly	Whether Laboratory maintained properly as per instructions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

DISTT. MEDICAL & HEALTH OFFICER

THE SAME PROFORMA MAY BE USED BY Dy. CMO (H)

M.F.-15

ZONAL OFFICER'S ACTIVITIES REPORT FOR THE MONTH OF___199_

District visited____________

Zone______________Period of visit from____________ ______to ____________

PART - I

1. **STAFF POSITION**

   (Complete or deficient, if deficient action taken to fill up the same)

2. Surveillance data up to the end of the month (Enclosure No.1) . ____________

   Enclose separate statement

3. No. of subcentres collecting blood slides ____________

   a) No. of subcentres collecting more than target ____________

   b) No. collecting less than target ____________

   c) Investigations for increase and shortfalls and action taken by the Zonal office to rectify defects ____________

4. Laboratory data up to the end of previous month

   Technicians , others

   a) No. of personnel examining the blood slides with training status ____________ ____________

   b) No. of microscopes and their condition ____________

   c) No. of blood slides cross-checked ____________

      1. State or Central Cross-Checking ____________

         Negative ____________

         Positive ____________

      2. ROH& FW Negative ____________

         Positive ____________

      Action taken to pinpoint the defaulters

d) Backlog of slides under:

Active	Passive	Mass & Contact

e) Timelag between:
Collection of blood slides & receipt in the Laboratory____________

5. Manintenance of stock register up to the end of previous month:

A) Insecticides ________________ Balance on ______________________________

B) Antimalarials : Balance on ____

4-A.Q., ______________ 8-A.Q.____________Sulpha+Pyri __________
Quinine Tab: ___________ Any other (Specify) _____________________

C) Vehicle position:

i) No. of vehicles off road ____

ii) Measures taken to make road worthy __________________________________

a) Monthly Technical Report submitted up to _______________________________

Action taken if delay in submitting ______________________________________

b) Annual report submitted for the Year ___________________________________

Reasons for non-submission & Action taken _________________________________

PART-II.

Field work for the current month:

1. Number of days toured by th Distt. Malaria Officer ____________________________

2. Number of night-halts made in the district ___________________________________

3. (a) Name of the villages visited in PHC,
for checking spray and surveillance: ______________________________________

Name of PHC	Within 1.5 km (1 mile) from road	Within 1.5 to 4.5 kms (1 to 3 miles) from road	Over 4.5 kms (3 miles) from road
1	2	3	4

b) For spraying, schedule spray timings and
deviations with reasons ____

c) Epidemiological investigations carried out during the month in
PHC and the number verified by himself ____________________________________

4. Institutions visited for passive surveillance checking

PHC ____

Hospitals ____________________________________

Dispensaries __________________________________

Steps taken if shortfall ____________________________

5. Contacts made with the District Collectors/Chief Medical Officers/Panchayats, etc.

   a) Progress in Drug Distribution through Panchayats/Teachers.

   b) Assistance in spraying from Panchayats.

PART-III: ADMINISTRATIVE

1. Punishment awarded/recommended to State Malariologist against any member of the staff, if reported no. and date of communication ______________________

2. Pending, reference on which action is required by the State Malariologist ______________________

3. Any other point which the Zonal Officer wants to bring to the notice of the DHS/State Malariologist. ______________________

ZONAL OFFICER (MAL.)

ENCLOSURE - I
ZONAL OFFICER'S ACTIVITY REPORT FOR THE MONTH OF --199--

Part I & II Surveillance Data up to the end of previous Month

	Fever Cases	B.S. Collection	B.S. Examination	Results				Entomo-logical investi-gations
				Pv	Pf	Mxd	Tot.	
Active								
Passive								
Mass & Contact								
Total								

ROGRESSIVE TOTAL UP TO THE END OF PREVIOUS MONTH

Active								
Passive								
Mass & Contact								
Total								

ZONAL OFFICER (MALARIA)

M.F. - 16

FOR REPORTING DRUG DISTRIBUTION CENTRES, FEVER TREATMENT DEPOTS AND MALARIA CLINICS

Name of the State____________________ ____   Report for the month of ______________

Sl.No.	District	DRUG DISTRIBUTION CENTRES				FEVER TREATMENT DEPOTS				MALARIA CLINICS			
		Number required	Number established	No. of cases attended during the month	Cumulative No. of cases attended up to date	Number required	Number established	Number of cases attended during the month	Cumulative number of cases attended up to date	Number required	Number established	Number of cases attended during the month	Cumulative number of cases attended up to date
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

NAME OF THE STATE ....
MONTHLY EPIDEMIOLOGICAL SITUATION REPORT FOR THE MONTH OF .... , 1995

S. No.	Name of the District	Year	During the Month					Progressive Total						Deaths			
			B.S.C.	B.S.E.	No. +ve	P.f.		B.S.C.	B.S.E.	No. +ve	P.f.		R.T.	During the Month		Progressive Total	
						R	RG				R	RG	Given	*Microscopically Confirmed	Clinically diagnosed	*Microscopically Confirmed	Clinically diagnosed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		1994 1995															
		1994 1995															
		1994 1995															
		1994 1995															
		1994 1995															
		1994 1995															
		1994 1995															
	Contd.																
	Total	1994 1995															

* The cases recorded under column 15 and17 are not to be repeated under column 16 and 18 respectively.

STATE ....

NATIONAL MALARIA ERADICATION PROGRAMME

CONFIRMED DEATHS DUE TO MALARIA FOR THE MONTH OF ....

Sl. No.	Name of the District	Name and Address of the deceased	Age	Sex	Date of Collection of B.S.	Date of Examination of B.S.	Species	Period of R.T.	If hospitalised, date of admission	Date expired on

Annexure- 6.2

UM Proforma - I

National Malaria Eradication Programme
Urban Malaria Scheme

Monthly Technical Report for the month of ____________________

(To be sent to the Director, NMEP, ROH & F.W., Programme Officer of the State and District Medical Officer by 10th of the following month).
by Malaria Inspector.

State ____________________ District ____________________ Unit / Town ____________________

Complete postal address ____________________

Telephone No. ____________________

Monthly Technical Report on Larvicidal Treatment of mosquito breeding sources

No. of men working		Breeding places checked & treated		Larvicides	Approx. area in hectares or in running Kilometres	Opening balance	Quantity consumed in ltrs.	Quantity received during the month	Balance at the end of the month	Minor Engineering works done.		NO. of wells or pools where Gambusia or Guppy introduced	Remarks
SFW	FW	Type	No.							Type	Approx sq. mtrs		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
				1.MLO 2.Fenthion 3.Temephos 4.Paris green 5.B. sphaericus 6.B. thuringiensis 7.AGLF 8.Others (Specify)						Canalisation Desilting Deweeding Filling Others			

Please strike off whichever is not applicable

UM Proforma - II

National Malaria Eradication Programme
Urban Malaria Scheme

Monthly Technical Report for the month of ____________________

Monthly Technical Report on Cross-checking work carried out and to be sent to the Director, NMEP, R..O.H. & F.W., State Programme Officer and District Medical Officer by 10th of the following month
by : 1. Malaria / Filaria Inspectors 2.. Verified by Biologist

State ____________________ District ____________________

Complete postal address ____________________

Ward/ Sector	Type of breed-ing places checked	No. of places checked for each type	Places found positive for breeding	No. found not treated	No. found with mosquito breeding								Remarks
					No. of dips applied	Culex			No. of dips applied	Anopheles			
						Per dip density				Per dip density			
						L I - II	L III - IV	Pupa		L I - II	L III - IV	Pupa	
1	2	3	4	5	6	7	8	9	10	11	12	13	14

REMARKS ____________________

Signature of Biologist / I/c Unit

UM Proforma -III

National Malaria Eradication Programme
Urban Malaria Scheme

Monthly Technical Report for the month of --
(to be sent to the Director NMEP, ROH & FW., State Programme Officer and District Medical Officer by 10th of the following month)
by Malaria Inspector / Filaria Inspector

State ______________________ District ______________________ Unit / Town ______________________

Complete postal address ____

Monthly Technical Report of space spray carried out

Incidence			Stock of P.E. / K. Oil	
During the month	Progressive total for the year		Pyrethrum extract 2%	Kerosene Oil
No. of fever cases reported		1 Opening balance of the month		
No. of B/slides collected		2. Received during the month		
No. found +ve for malaria.	Pf.	3. Consumed during the month		
	Pv.	4. Balance at the close of the month		
	Mixed			
Treatment given i) Radical ii) Presumptive				

Ward/Sector ______________________ No. of houses given space spray ______________________ Quantity of material used
Pyrethrum Extract______ Kerosene Oil ______ Remarks______

Signature of Biologist / I/c Unit

UM Proforma - IV

National Malaria Eradication Programme
Urban Malaria Scheme

Monthly Technical Report for the month of --
(Mosquito collection & dissection report to be sent monthly to reach DMO. AD (PH) ROH & F.W. and Director, NMEP, Delhi by 10th of the following month)
By Insect- collector

State ______________________ District ______________________ Unit / Town ______________________

Mosquito collection ____

Species	No of Insect Collectors in position	Fixed Catching Stations			Random Catching Stations			Total				Density per 10 man hours
		Time spent	No colleced		Time Spent	No collected		Time Spent	No. Collected			
			M	F		M	F		M	F	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13
An. culicifacies												
An. stephensi												
Other *Anopheles*												
C. quinquefasciatus												
An. aegypti												
Other *Culex*												

UM Proforma -V

National Malaria Eradication Programme
Urban Malaria Report

Monthly Technical Report showing staff position, equipment, utilisation and consumption of DEC, Chloroquine and Primaquine tablets for the month of ....
(to be sent monthly to DMO, AD (PH) and Director NMEP as well as ROH & FW by 10th of the following month)

State_______________ District _______________ Unit / Town _______________

1. STAFF

a) Persons Untrained (No.)
   i) Medical Officer/ Biologist
   ii) Inspectors & Technicians

b) Vacancies — No of posts

Name of the post	Sanctioned	in position
1		
2		
3		

II. EQUIPMENTS

Item	No. in hand	No. in use	No. not in use and since when	Remarks
1. Jeeps				
2. Trailers				
3. Dissecting microscopes				
4. Compound Microscopes				
5. Hand Compression sprayers				
6. Knapsack sprayers.				
7. Oil drums				

III. CONSUMPTION OF CHLOROQUINE, DEC TABLETS

	Chloroquine	Primaquine	DEC	Others (specify)
1. Opening balance at the beginning of the month				
2. Received / purchased during the month.				
3. Total (1 & 2)				
4. Stock consumed / diverted during the month				
5. Balance in hand at the end of the month.				

UM Proforma -VI

National Malaria Eradication Programme
Urban Malaria Scheme

Monthly Technical Report for the month of --
(To be sent to the Director NMEP, ROH & FW, State Programme Officer and District Medical Officer by 10th of the following month)

State_______________District _______________ Unit / Town

Cross-Checking and remedial measures

Sl. No.	Ward / Sector	Type of breeding sources	Type of remedial measure now taken	Timelag between reporting of breeding & treatment	Disciplinary action taken against defaulters	Remarks
1	2	3	4	5	6	7

UM Proforma -VII

URBAN MALARIA SCHEME

MONTHLY MOSQUITO DENSITY PROFORMA (CONCISED)

To be sent to DMO, AD(PH) R.O.H. & FW and Director NMEP

State__________ Month__________ Year __________

Adult density per man hour (Average worked out from fixed and random catching stations as recorded in the register)

A. culicifacies	*A. stephensi*	Other *Anopheles*	*Culex quinquefasciatus*	*Aedes aegypti*	Other *Culex*	Remarks for not recording mosquito density
1	2	3	4	5	6	7

Larval density per dip (Average worked out from weekly reports)

Anopheles larvae	*Anopheles* Pupae	*Culex* larvae	*Culex* Pupae	Remarks
1	2	3	4	5

UM Proforma - VIII

URBAN MALARIA SCHEME

STATEMENT OF MONTHLY EXPENDITURE AND STAFF POSITION

(To be sent to DMO, AD (PH), ROH & FW & Director, NMEP)

State__________ District__________ Unit / Town __________

Month__________ Year __________

Sl. no.	Staff Position		Expenditure on pay of all staff	Progressive total of expenditure on staff	Remarks
	No. sanctioned	No. in position			
1	2	3	4	5	6

Annexure- 6.3

FORM - 1

List of the code no. of different vectors, insecticides and various surfaces as given by Computer Maintenance Corporation (C.M.C) for different proformae for entomological data computerisation.

Species & Surfaces code for CMC

CODE NO.	MALARIA VECTORS
01	*Anopheles culicifacies*
02	*An. stephensi*
03	*An. fluviatilis*
04	*An. philippinensis*
05	*An. sundaicus*
06	*An. dirus*
07	*An. minimus*
08	*An. varuna*
09	*An. annularis*
	FILARIA VECTORS
10	*C. quinquefasciatus*
11	*Mansonioides (M) annulifera*
12	*M.uniformis*
	J.E.VECTORS
01	*Culex vishnui*
02	*C. pseudovishnui*
03	*C. tritaeniorhynchus*
04	*C. gelidus*
05	*C. fuscocephala*
06	*C. whitmorei*
07	*C. epidesmus*
08	*C. bitaeniorhynchus*
09	*Anopheles barbirostris group*
10	*An. hyrcanus group*
11	*An. subpictus*
12	*Mansonioides (M) annulifera*
	KALA - AZAR VECTORS
01	*Phlebotomus argentipes*
02	*P. papatasi*
03	*P. sergenti (vector of cutaneous leishmaniasis)*

CODE NO.	TYPE OF SURFACE
01	Mud plastered surface
02	Cemented surface
03	Wooden surface
04	Bamboo surface
05	Thatched surface
06	Others

CODE OF INSECITICIDE

CODE NO.	INSECITICIDE
DDT	DDT
MLN	Malathion
BHC	BHC (HCH)
DLD	Dieldrin
FEN	Fenthion
PIP	Pirimiphos-methyl
DEL	Deltamethrin
CYF	Cyfluthrin
ICO	Lambdacyhalothrin
TEM	Temephos
PRO	Propoxure
FTO	Fenitrothion

NMEP
COMPUTERISED ENTOMOLOGICAL DATA MONITORING MALARIA & FILARIA VECTOR MOSQUITO (ADULT) DENSITY.

Form - 2

State ____________ Record Type - 01

1. District code ☐☐☐☐☐☐☐☐☐
2. PHC Name ____________
 and Population under spray
3. Locality ________________
4. Date of collection ☐☐-☐☐-☐☐☐☐
5. Time of collection ☐☐ morn. ☐☐ eve.
6. Insecticide sprayed (code of insecticide) ☐☐☐
7. Spray coverage % — Population ☐☐☐ Room ☐☐☐ House ☐☐☐ CS ☐☐☐
8. Date of spray — Day ☐☐ Month ☐☐ Year ☐☐☐☐
9. Time spent in hours — Indoors ☐☐ HRS ☐☐ MTS; Outdoors ☐☐ HRS ☐☐ MTS

	Code	Male	Female	10 man-hour density
10. Vectors of Malaria	☐	☐	☐	☐
	☐	☐	☐	☐
	☐	☐	☐	☐
11. Other *Anopheles* (specify species)	☐	☐	☐	☐
12. Vectors of Filaria	☐	☐	☐	☐

N.B.- when in a PHC more than one insecticide is used, code of other insecticide(s) also to be written with plus mark.

N M E P

Computerised Entomological Data Monitoring (ADULT)
Density of Vectors of J.E and Kala-azar.

Form - 3

State ____________ Record Type - 01

1. District code [ ][ ][ ][ ][ ][ ][ ]

2. PHC Name ________ and total population of PHC

3. Date of collection [ ][ ] - [ ][ ] - [ ][ ][ ][ ]

4. Time of collection MORN. [ ][ ] EVEN. [ ][ ]

5. Locality [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

6. Insecticide sprayed [ ][ ][ ]

7. Spray Coverage% Population [ ][ ][ ] Room [ ][ ] House [ ][ ] CS [ ][ ]

8. Date sprayed Day [ ][ ] Month [ ][ ] Year [ ][ ][ ][ ]

9. Time spent in hours Indoors [ ][ ] Outdoors [ ][ ]

10. Vectors of J.E.

Code	Male	Female	10 man-hour density
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]

11. Vectors of Kala - azar

Code no.			Density (P.M.H.)
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]

NMEP

COMPUTERISED ENTOMOLOGICAL DATA MONITORING SUSCEPTIBILITY TEST ADULT MOSQUITO FORM.

FORM-4

State ____________

DISTRICT CODE: [| | | | | | | |]

PHC NAME OR NAME OF LOCALITY ____________ DATE OF TEST [| | - | | - | | | |]

DAY MONTH YEAR

EXPOSURE PERIOD :	SPECIES CODE [|]			SPECIES CODE [|]			SPECIES CODE [|]			SPECIES CODE [|]		
	TT	D	% MORT	TT	D	% MORT	TT	D	% MORT	TT	D	% MORT
OC - CONTROL :												
DDT 4% :												
DL 0.4% :												
DL 4% :												
OP - CONTROL :												
MLN 5% :												
FENITRO 1% :												
CB - CONTROL :												
PROPOXURE :												
SP - CONTROL												
DELTAMETHRIN :												
CYFLUTHRIN :												
LAMBDACYHALOTHRIN												
TEMPERATURE :	MAX :			MIN :								
RELATIVE HUMIDITY												

TT = TOTAL TAKEN, D = DEAD, MORT = MORTALITY

NMEP

COMPUTERISED ENTOMOLOGICAL DATA MONITORING SUSCEPTIBILITY TEST (LARVAL) FORM.

FORM-5

State ____________

DISTRICT CODE: [| | | | | | | |]

PHC NAME OR : NAME OF LOCALITY ____________ DATE OF TEST [| | - | | - | | | |]

DAY MONTH YEAR

MINUTES

EXPOSURE PERIOD : [| | |]

	SPECIES CODE [|]			SPECIES CODE [|]			SPECIES CODE [|]			SPECIES CODE [|]		
	TT	D	% MORT	TT	D	% MORT	TT	D	% MORT	TT	D	% MORT
OP Control :												
Fenthion 0.25 mg./1 :												
Fenthion 1.25 mg./1 :												
Fenthion 6.25 mg./1 :												
Fenthion 31.25 mg./1 :												
Temephos 1.25 mg./1 :												
Temephos 6.25 mg./1 :												
Temephos 31.25 mg./1 :												
Temephos 156.25 mg./1 :												
Other larvicides :												
Temperature												
Relative humidity		Maximum			Minimum							

TT = Total taken D = Dead MORT.= Mortality

NMEP
COMPUTERISED ENTOMOLOGICAL DATA MONITORING-DISSECTION FORM.

FORM-6

State

DISTRICT CODE : [ ] DATE : MONTH YEAR : SPECIES CODE :

PHC NAME

ABDOMINAL CONDITION (GIVE NUMBER OF MOSQUITOES) UF F SG G

		GUT		GLAND	
DISSECTION	NO.DISSECTED	[ ][ ][ ][ ]	NO+VE [ ][ ]	NO.DISSECTED [ ][ ][ ]	NO.+VE [ ][ ]
OVARIAN DISSECTION	NO.DISSECTED	[ ][ ][ ][ ]	NO.NULLIPAROUS [ ][ ][ ][ ]	NO.PAROUS P1 P2 P3 P4 [ ][ ][ ][ ]	
FILARIA	NO.DISSECTED	[ ][ ][ ][ ]	NO.+VE FOR Mf [ ][ ]		

NO. +VE FOR INFECTION WITH LARVAL STAGES I II III III ONLY [ ][ ][ ][ ] [ ][ ]

AVG. NO. OF INFECTIVE LARVAE PER INFECTIVE MOSQUITO [ ][ ]

P1.......4 = PAROUS 1, 2, 3 ,4
F = FULL FED
G = GRAVID
UF = UNFED
SG = SEMI GRAVID

NMEP
COMPUTERISED ENTOMOLOGICAL DATA MONITORING
WHOLE NIGHT VECTOR BITING COLLECTION

FORM - 7
RECORD TYPE - 01

TATE

ISTRICT CODE [ ][ ][ ][ ][ ][ ][ ] PHC NAME [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

ATE [ ][ ] - [ ][ ] - [ ][ ][ ][ ]
DAY MONTH YEAR

NO.OF HUMAN BAITS [ ][ ] NO. OF ANIMAL BAITS [ ][ ]

EATHER CONDITIONS (TICK MARK) -WINDY [ ] RAIN [ ] NO WIND [ ] FOG [ ] CLOUDY [ ]

IGHT HOURS OF COLLECTION	VECTORS COLLECTED PER HUMAN BAIT INDOOR VECTORS CODE-WISE	VECTORS COLLECTED PER HUMAN BAIT OUTDOOR VECTORS CODE-WISE	VECTORS COLLECTED PER ANIMAL BAIT INDOOR VECTORS CODE-WISE	VECTORS COLLECTED PER ANIMAL BAIT OUTDOOR VECTORS CODE-WISE	AEDES COLLECTED PER BAIT HUMAN INDOOR	AEDES COLLECTED PER BAIT HUMAN OUTDOOR	AEDES COLLECTED PER BAIT ANIMAL INDOOR	AEDES COLLECTED PER BAIT ANIMAL OUTDOOR
18-19 HOURS	[ ][ ][ ][ ]	[ ][ ][ ][ ]	[ ][ ][ ][ ]	[ ][ ][ ][ ]	[ ][ ]	[ ][ ]	[ ][ ]	[ ][ ]
19-20								
20-21								
21-22								
22-23								
23-00								
00-01								
01-02								
02-03								
03-04								
04-05								
05-06								

N.B.-Per HUMAN OR ANIMAL BAIT COLLECTED VECTOR NIGHT HOURWISE TO BE WRITTEN BELOW THE CODE OF VECTOR (IN VERTICAL DIRECTION)

NMEP
COMPUTERISED ENTOMOLOGICAL DATA MONITORING
SPACE SPRAY TOTAL CATCH (PYRETHRUM SPRAY)

FORM-7a

1. State ____________________
2. District code □□□□□□ PHC Name ____________ Date □□-□□-□□□□ (Day Month Year)
3. Time of collection □ Morn. □ Even.
4. Date of last spray and code of insecticide □□-□□-□□□□ □□
5. Place of collection □ Human Dwelling □ M.D. □ Cattle Shed
6. Total Number of Mosquitoes collected Species wise

Malaria vectors: Code	Malaria vectors: No. collected	Other Anophelines: Name or code	Other Anophelines: No. collected	Culicine: Name or code	Culicine: No. Collected	Kala-Azar vectors: Code	Kala-Azar vectors: No. Collected
□□	□□□	□□	□□□	□□	□□□	□□	□□□
□□	□□□	□□	□□□	□□	□□□	□□	□□□
□□	□□□	□□	□□□	□□	□□□	□□	□□□
□□	□□□						

7. Weather Conditions:- Windy □ Rain □ Dry □ Cold □ Hot □

NMEP
COMPUTERISED ENTOMOLOGICAL DATA MONITORING
CONTACT BIO-ASSAY FORM.

FORM-8

State ____________

District code __________ : Date: Month: Year: Species code: surface code:

PHC name __________ :

Insecticide sprayed (write code) : □□ Date sprayed: Exposure period:

Abdominal condition (Female) : Full fed □ Unfed □ Gravid □

Control : No. exposed □ No. Dead □ %Mort □

On contact surfcace : No. exposed □ No. dead □ % Mort □

Temperature : Relative Humidity

NMEP FORM-9

COMPUTERISED ENTOMOLOGICAL DATA MONITORING MOSQUITO LARVAL COLLECTION FORM

State ______________________

1. District code ☐☐☐☐☐☐
2. Name of Locality ______________________
3. Name of PHC ______________________
4. Date of collection ☐☐ – ☐☐ – ☐☐☐☐
   Day Month Year
5. Distance from nearest house (In metres) ☐☐☐
6. Breeding places

Breeding places	No. checked	No. found positive with species of mosquito (code): Vector mosquito code	No. found positive with species of mosquito (code): Other mosquito species' (Give name)
-Sullage water drains	☐	☐☐☐	☐☐☐
-Cess pits	☐		
-Cess pools	☐		
-Septic tanks	☐		
-OHT	☐		
-Cisterns (Fresh water)	☐		
-Barrels	☐		
-Earthen pitchers/containers	☐		
-Rejected Tyres/Utensils	☐		
-Ornamental tanks	☐		
-Wells-unused	☐		
-Wells-used	☐		
-Fresh water channels	☐		
-Irrigation canals	☐		
-Seepage water	☐		
-Rice fields	☐		
-Lakes	☐		
-Pit/low lying water collections	☐		
-Rain water collections	☐		

N.B. - Number of breeding places found positive in each type is to be written under the mosquito code.

NATIONAL MALARIA ERADICATION PROGRAMME
COMPUTERISED ENTOMOLOGICAL DATA MONITORING
ANALYSIS OF BREEDING PLACES POSITIVE WITH MOSQUITO BREEDING

FORM-10

District code [ ] Locality ____________ State ____________ Date of collection ____________

PHC Name ____________

	PER DIP DENSITY IN + VE BREEDING PLACES													
	Sullage water drains	Septic Tanks	Cesspits	Cesspools	OHT	Cisterns/ Barrels	Ornamental Tanks	Wells	Irrgn. Canal	Seepage Water	Rice Fields	Lakes	Rain Water Collcn.	Rejected Tyres, Utensils
ANOPHELES														
Vector species code														
L-I-II														
L-III-IV														
PUPA														
Other species														
L-I-II														
L-III-IV														
Pupa														
CULEX														
spec:														
L-I-II														
L-III-IV														
PUPA														
AEDES														
L-I-II														
L-III-IV														
PUPA														

N M E P
COMPUTERISED EPIDEMIOLOGICAL DATA MONITORING

FORM - 11

STATE ____________ DISTRICT CODE [| | |] PHC CODE [| | | |]

[| | - | | | |]

MONTH YEAR

EPIDEMIOLOGICAL DATA FOR 2 YEARS (COMPARATIVE)

1. POPULATION OF PHC [| | | | | |]
2. BS COLLECTED AND EXAMINED (PROGRESSIVE) - CURRENT YEAR [ ] - PREVIOUS YEAR COMPARATIVE [ ]
3. TOTAL MALARIA POSITIVE CASES - CURRENT YEAR [ ] - PREVIOUS YEAR COMPARATIVE [ ]
4. NUMBER OF *P falciparum* CASES - CURRENT YEAR [ ] - PREVIOUS YEAR COMPARATIVE [ ]
5. ABER - CURRENT YEAR [ ] - PREVIOUS YEAR COMPARATIVE [ ]
6. API - CURRENT YEAR [ ] - PREVIOUS YEAR COMPARATIVE [ ]
7. SPR - CURRENT YEAR [ ] - PREVIOUS YEAR COMPARATIVE [ ]
8. SfR - CURRENT YEAR [ ] PREVIOUS YEAR COMPARATIVE [ ]
9. SPRAY DURING CURRENT YEAR
   - NO. OF ROUNDS SPRAYED [ ]
   - TYPE OF INSECTICIDE USED CODE [ ]
   - DATE OF SPRAY [| - | | - | | | |]

     DAY MONTH YEAR

SELECTED REFERENCES

1. Covell, G. (1927): Anti-mosquito Measures with special references to India. *Health. Bull. No.* **11**. *Malaria Bureau (Eight Edition* - 1960).

2. Hara S.L. and Mukherji (1953): Table for the identification of Indian fresh water Fishes, with description of certain families and observations on the relative utility of the probable larvivorous fishes in India. *Health Bull. No.* **12**; *Bulletin NO. 4 - 1953 (Third Edition).*

3. Kondrashin, A.V. and Rashid, K.M.(Ed.) (1987): Epidemiological consideration for planning malaria control in South East Asia. WHO/SEARO *Technical Publication No.* **17**, New Delhi.

4. Molineaux, L. and Gramiccia, G. (1980): The Garki Project Research on Epidemiology and Control of Malaria in the Sudan, Savanna of West Africa. Published by. World Health organisation Geneva.

5. (NMEP 1995): Operational Manual for Malaria Action Programme. Published by the Dte. of NMEP, 22-Sham Nath Marg, Delhi - 110 054.

6. Ray, A.P.(1965): Technical Directive and Administrative Guidance - NMEP. *Bull Nat. Soc. India Mal. other Mosq. Borne. Des,* **11**:59.

7. Singh, G.P., Chitkara, S., Kalra, N.L., Makepur, K.B. and Narasimham, M.V.V.L. (1990): Development of a methodology for malariogenic stratification as a tool for malaria control. *J.communic. Dis.*,**22**:1.

8. WHO(1973): Manual on Larval control operations in Malaria programmes published by WHO, Geneva.

9. WHO(1982): Biological control of vector of Disease *Tech. Rep. Ser. No.* **679.**

7

MALARIA CONTROL STRATEGY AND NMEP POLICY

SECTION-1
INTEGRATED DISEASE VECTOR CONTROL

INTRODUCTION

India made progress in the control of many communicable diseases in the recent past. The country proudly shared the global achievement of smallpox eradication. It made a laudable progress in reaching near 'O' status for guineaworm cases in the country during the current year and is on the verge of declaring eradication of the disease in the near future. The country has also taken up the goal of eradicating polio soon. Lymphatic filariasis is now identified by the International Task Force for Disease Eradication as one of the infectious diseases considered eradicable or potentially eradicable.

Unfortunately malaria continues to be a major public health problem in India. Though morbidity of the disease has been reduced by over 97 per cent now as compared to pre-eradication figures, the incidence is stabilised at about two million cases per annum during the last one decade. The only satisfying aspect in the incidence is that although the population of the country has increased by about 25 per cent as compared to 1984, the incidence did not show increasing trend. It is now realised that the disease cannot be eradicated by the turn of the century considering the ground realities in a pragmatic approach. The containment efforts need to be rescheduled. The programme managers are to draw a long-term plan of operation to drastically bring down morbidity and eliminate mortality due to malaria in the next one decade.

It is worth recalling the announcement made by Sir Winston Churchill, former Prime Minister of Great Britain in the British Parliament on December 2, 1944 about despatch of DDT, then a new chemical for malaria control in India, that the Army Medical Authorities at GHQ New Delhi issued the warning that 'DDT is a powerful new weapon. It should be stressed that it is a reinforcement and not a substitute for existing well tried systems of malaria control which on no account should be relaxed.'

Unfortunately the above warning was totally ignored and the chemical insecticide ruined the 'Environment Management Methods' which were harnessed for over 40 years prior to introduction of DDT in the country.

Paradoxically, the history is repeating itself and now the stress is on the adoption of environment management methods for the control of malaria and other mosquito borne diseases as a long term strategy.

In the future, the following strategies need to be accorded priority for containtment of malaria in India to improve prospects of malaria control.

1. Early case diagnosis and prompt treatment (EDPT).

2. Selective Vector control by appropriate insecticidal spray in rural areas having annual incidence of two or more cases per thousand population and recurrent antilarval measures in the urban areas.

3. I.E.C and community participation.

4. Intersectoral coordination.

5. Introduction of synthetic pyrethroids impregnated bednets in persistent transmission areas.

6. Epidemic prevention and rapid control measures.

7. Capacity building.

8. Operational research.

STRATEGY FOR INTEGRATED DISEASE VECTOR CONTROL

The drawbacks of chemical insecticides have made the health authorities in many countries to shift gradually to environmental management methods and integrated control approach as the indoor residual spray of insecticides has been facing many a problem such as **i.** opposition by the residents to get their houses sprayed, **ii.** lack of adequate supervision to achieve good coverage within the scheduled dates, **iii.** precipitation of resistance in the vectors, **iv.** persistence of some insecticides in the environment for prolonged period and increased toxicity of alternative insecticides, **v.** high cost of insecticides and **vi.** strong opposition by environmentalists for their use.

The WHO Expert Committee on Vector Biology and Control (1983) has elucidated that the integrated vector control can be considered as the utilization of all appropriate technological and management techniques to bring about an effective degree of vector suppression in a cost-effective manner. In other words, the integrated control of disease vectors is defined as the involvement of the coordinated application of complimentary counter-measures that combine (concurrent or consecutive) to minimise vectorial capacity in a cost-effective manner.

The essential prerequisite of integrated vector control is the availability of more than one method of control or the ability to use one method that favours action of another method. It envisages the development and deployment of several control methods concurrently/consecutively.

The major methods of control comprise of, **i.** personal prophylactic measures, **ii.** habitat management and source reduction, **iii.** use of chemical larvicides and adulticides, **iv.** biological control agents and **v.** manpower development and IEC.

Most of the technologies mentioned above have been elaborately dealt with in different Chapters of this book.

In India, the major diseases that can be combined for integrated disease vector control are: **i.** Malaria, **ii.** Filaria, **iii.** Kala-azar, **iv.** Japanese Encephalitis and **v.** Dengue. At present the control of first three diseases is implemented under the technical guidance of the Directorate of NMEP and the control of the latter two diseases will be brought under the aegis of the national programme during IX Plan period. Vector control aspects of filariasis will be covered under the Urban Malaria Scheme, since the main strategy for elimination of filariasis is by single dose mass DEC therapy once a year.

Community Participation in Vector Control

Community involvement and active participation will be very essential for successful implementation of Integrated Disease Vector Control (IDVC) methods. The following components require to be considered for achieving the goals of the integrated vector control strategy.

i. Primary Health Care System for IDVC

IDVC should be an integral part of Primary Health Care System which is based on the principle of 'equity and justice' in the use of prevailing social and financial resources giving due emphasis on individual and community self-reliance in health matters.

ii. Community Involvement

Active community participation plays an important role for the sustained success of IDVC. The WHO Expert Committee has enunciated that community participation is a process whereby individuals, families and community are involved from the beginning in planning the vector control programme as well as local vector control activities, so as to ensure that the programme and its activities meet the local needs and priorities and become shaped around the people's life-style & patterns and promote community self reliance in respect of development. The broad approaches for community participation are:-

a. intra-and intersectoral cooperation and coordination.

b. Socio-economic and cultural aspects ensuring the acceptability of the choice of vector control method(s).

c. Health education as an integral part of IDVC and

d. Community organisation for sustained participation of the community in vector control.

iii. The Role of Community

The community can help at the following three levels:

a. The community can help vector control in the form of paying taxes for vector control or cooperation in getting houses sprayed or self-help contribution. The community can help at National, State or local projects.

b. The vertical programmes hitherto in operation (wherever applicable) may be gradually be entrusted to the community through subsidised or voluntary labour such as spraying of houses.

c. Personal protection measures namely use of mosquito bednets, screening of houses, use of repellents, etc. to prevent man-mosquito contact.

iv. Criteria for Vector Control Measures

The following criteria should be met for community based vector control methods.

a. The material and equipments are to be made available.

b. The skills for vector control are easily acquired.

c. The methods of control do not invoke high costs.

d. The control strategy is beneficial to local enterprises.

e. The toxicity is within the accepted levels.

f. The control strategy is environmental friendly.

g. The method is efficient and well tested in the past.

h. The control methods are in consonance with local socio-cultural practices.

v. Manpower Development

The experts from relevant disciplines such as social scientists, opinion leaders, and community organisers are to be involved for promoting vector control measures. The training programme should encompass: **a.** Development of curriculum for community participation, **b.** the faculty shall possess expertise in the relevant topic, **c.** actual field oriented experience is gained in community based studies.

vi. Constraints on Community Participation

The following constraints should be taken into consideration for solving the bottlenecks for health promotion at community level. These include lack of:- **a.** co-ordination among organisers, **b.** effective local self-government **c.** know-how in the implementation of control strategy, **d.** adequate motivation, **e.** supervision at peripheral levels **f.** interest by the community, **g.** affordable cost in the initial stage **h.** sustainability **i.** short term or quick yielding methodology and **j.** lack of ownership of the programme at individual level.

2. Personal Protection Measures

These mainly comprise of:- **i.** Site selection, **ii.** Mosquito proofing of houses, **iii.** Zooprophylaxis (animal barrier), **iv.** Use of clothing, **v.** Use of mosquito repellent creams, coils, mats, etc and **v.**

Use of bednets/curtains: Impregnated with insecticide.

The salient aspects of each method are discussed hereunder:

i. Site Selection

The siting of township is detailed in Chapter-8 and here the siting of individual houses is discussed. It is well known that highest densities of mosquitoes are encountered in dwellings constructed in the vicinity of mosquito breeding places. If the houses are built away from the normal flight range of the mosquitoes, the man-mosquitoes contact will be drastically reduced. It is ideal if the houses are constructed at least 2 km away from the mosquito breeding sources. However, some mosquitoes could fly such distances as well (i.e. 2 km) but the risk of establishing transmission is extremely low. Site selection alone will not be sufficient to ward off man-mosquito contact. Environmental water management should be undertaken to prevent the peri-domestic breeding of some of the known disease vectors. It is advantageous that the houses are constructed on high ground levels and subjected to wind currents. Since the wind currents passively help in the dispersal of mosquitoes beyond the normal flight range, it is better that the houses are located on the windward side rather than on the leeward side of the mosquito breeding sources. Higher ground levels also facilitate natural drainage of rain as well as sullage water. Sandy and porous soils do not normally become waterlogged as compared to clayey and impermeable layers of soil. Good ventilated dwellings with large windows and smooth ceilings are not preferred resting places for mosquitoes. Houses with less ventilation, dark recesses, cupboards, old curtains, hanging objects and more furniture attract mosquitoes. Houses constructed in the proximity of cattle sheds also attract large number of mosquitoes.

ii. Mosquito Proofing of Houses

Screening of houses should be preferred wherever feasible and affordable. All the members of household are protected once they are inside the house. The inhabitants can perform normal household chores. It gives protection from other pests also. Unfortunately most of houses in rural areas are thatch roofed with eaves and hence are not suitable for mosquito proofing. Moreover the cost of mosquito proofing is beyond the financial resources of majority of rural community.

iii. Zooprophylaxis (Animal Barrier)

Among malaria vectors in India *An.minimus* and *An.sundaicus* are highly anthropophilic while *An.culicifacies* and *An.annularis* are highly zoophilic. Many mosquitoes exhibit faculative feeding patterns and readily feed on man or animal. Man-cattle ratio plays pivotal role in malaria transmission, especially by *An.culicifacies*. Though the vector exhibits high zoophilic index, it readily feeds on man causing fulminating malaria epidemics in project area where the cattle population is absent or negligible.

Zooprophylaxis is a well recognised phenomenon in reducing malaria endemicity in some endemic parts of the world. It is useful in places where cattle and other livestock form an integral part of agriculture economy. Zooprophylaxis not only helps diversion of infected mosquitoes to animals decreasing man-mosquito contact but also feeding of mosquitoes on animals prevents the magnitude of human reservoir hosts. Zooprophylaxis is useful in areas where the vector has zoophilic or faculative blood feeding pattern. In zooprophylactic technique, the cattle or other domestic animal sheds are established around the villages in the interceptor zone between the mosquito breeding places and human dwellings and a minimum distance of 250 metres should be kept between the human dwellings and animal sheds.

iv. Use of Clothing

Clothing prevents mosquito biting, if the cloth is sufficiently thick or loose from the body. Use of long sleeves and trousers with stockings protects arms and legs from mosquito bites which practice is included in military regulations. Wearing of dark clothing attracts more mosquitoes.

v. Use of Mosquito Repellents, Creams, Coils and Mats

An ideal mosquito repellent should meet the

criteria such as safety to the user and efficacy against mosquito biting throughout the biting period of vector with a single application of repellent before going to bed. If the mosquito is an early biter, the repellent should be applied at dusk. The repellents should liberally be applied on all parts of body except eyes. In the past, citronella oil was the commonly used repellent but several compounds more effective than citronella have come into use.

Presently dimethyl pthalate and diethyltoluamide are commonly used as repellents.

Clothing can also be impregnated with repellents in the last rinsing of washing containing 10-20% repellent.

Mosquito coils and ropes are also used containing formulation of natural pyrethrins. The lighted coil/rope should emit sufficient varpours of pyrethrum for the entire night-biting period of the vector. Effect of long term exposure to coils and mats has not been studied.

Mats treated with synthetic pyrethroids have become more popular recently and the duration of efficacy varies for different makes giving 60 to 80% protection only. This method is costly and out of reach of many residents.

vi. Use of Insecticide Impregnated Bednets

Selection of the Area

Large scale use of insecticide impregnated bednets should be cautiously introduced in the programme on pilot basis and after its evaluation this method could be extended to other areas in a phased manner. Insecticide Impregnated Bednets (IIBN) will be epidemiologically effective to control malaria generally in those areas which satisfy any of the following criteria.

a. **SPR during the last three consecutive years should be 5%. or less.**

b. **The transmission dynamics should indicate that the mosquito is an indoor biter and the biting time starts after 9 p.m. reaching the peak rhythm in the midnight or late night and also preferably an indoor rester.**

c. Use of benets is in practice in the selected area and the method is acceptable to the community.

d. This method can be used in areas where the temperature and humidity are low or moderate since bednets are not generally used by the community where temperature and humidity are high.

e. Remote inaccessible malarious areas like 'Jhum' agricultural farms where indoor residual insecticidal spray is not feasible.

f. There should be flexibility to change the strategy according to local situation.

Synthetic pyrethroids are used for impregnating the bednets. This compound is technically effective to repel or kill the vector. It is biodegradable and hence does not re-cycle in the nature. This method has been found to be cost-effective. It has also been observed in field studies that certain proportion of people buy their own bednets and sachets of synthetic pyrethroids for re-impregnation of bednets. Community cooperation and participation through proper health education will make this method more sustainable.

The areas having the criteria mentioned above should have established community organisation like Gram Panchayat, Mahila Mandals, etc., where the Departments of Social Welfare, Tribal Development and Health Care Delivery System are fully staffed, may be initially selected for distribution of IIBN. Initially one PHC in the selected district will be covered and gradually extended to other PHC areas of the district where indoor residual insecticidal spray will be withdrawn. This method shall not be extended to hardcore PHCs where withdrawal of indoor residual spray is not technically recommended.

Preparation of Area

Intensive IEC Programme is to be taken up on IIBN highlighting the methodology of use and beneficial effects. Person to person and group communication will be used through various media. It will be followed by geographical

reconnaissance of area to find out number and size of bednets and quantity of synthetic pyrethroid required for the selected area. Survey may be carried out to ascertain the purchasing capacity of family to buy the net at actual cost or subsidised cost and mode of payment i.e. single payment or deffered payment.

The population could be divided into four categories on the basis of purchasing capacity. The four groups could be, **a.** self purchase, **b.** 50% subsidy, **c.** 75% subsidy, **d.** 100% subsidy. The criteria for economic categories for the selected district may be decided by the 'District Malaria Committee'. The mode of payment by the individual groups could be one time payment, or three or six equal instalments at monthly interval.

Quality of Bednets

The standard bednet hole size should not be bigger than 1.2 to 1.5 mm diameter, having round/hexagonal shape. Nylon nets are preferable over cotton nets because the former are more durable, quicker in drying after impregnation and the insecticide stays longer on the surface of nylon fibre.

Dosage

The dosage of 25 mg/sq metre of Deltamethrin/Lambdacyhalothrin or 50 mg/sq metre of Cyfluthrin is recommended based on field trials carried out in India. Thus 1 gm of Deltamethrin (2.5%) or 0.5 gm of Cyfluthrin (10%) or 0.25 gm of Lambdacyhalothrin (10%) will be required per one sq metre. The insecticide could be supplied in two types of sachets to impregnate a single or a double bednet, if the nets are of standard measurement.

Methodology

The surface area of bednet can be determined by measuring the area of each of the four sides and top i.e. 2 (length + breadth) X height + (Length X breadth) = Total area.

The water absorbing capacity of the net is to be calculated by trial and error. The absorption capacity differs for different makes of material. The optimum quantity of water required for impregnation is to be determined. The moist net is hung for drying in shade on a metal wire and there shall not be any dripping of water. The impregnation will be demonstrated initially to the group gatherings on a convenient day where the villagers can get their bednets impregnated with insecticide.

Residual Efficacy

When not washed, the impregnated net will have efficacy for six months. If washed, the impregnation may be done afresh.

Precautions

a. The person impregnating the bednet should wear rubber gloves, **b.** He should avoid contamination of skin, eyes and mouth with insecticide formulation and **c.** If accidentally contaminated, wash the body part with soap and water in the surgeons' fashion.

Distribution of Bednets

After ascertaining the requirement of single and double bednets and quantity of synthetic pyrethroid, the data for PHC will be consolidated and the total requirement for the district will be calculated.

The District Malaria Committee comprising of District Collector or Zila Parishad head as Chairman and Chief District Medical Officer, District Welfare Officer, Tribal Welfare Officer, Revenue Officer with 3-4 Sarpanchs as members and District Malaria Officer as Member Secretary may be responsible to procure the total requirement of bednets and synthetic pyrethroid for the district. Further distribution of the supplies to the PHC level may be done by District Malaria Committee which shall maintain the records. Similarly Block Malaria Committee consisting of MO PHC, Panchayat Samithi Members, Block Development Officer, Agriculture Extension Officer, etc may be responsible at PHC level. Likewise the distribution of supplies may be made to villagers through Village Malaria Committee comprising of Voluntary Link Worker, FTD/DDC holders, Anganwadi Worker, Gram Panchayat Members, etc.

The final distribution of bednets to the villagers on the subsidised rate and collection of

payment could be the responsibility of Malaria Link Worker or any other functionary identified by the District Malaria Committee in consultation with the Block

Malaria Committee. The money so collected could be deposited in a Bank account operated by the District Malaria Committee.

The money could be used as revolving fund to purchase synthetic pyrethroid sachets for the impregnation, organisation of malaria week and initial expenditure for epidemic preparedness and containment. The guidelines for use of revolving fund may be finalised at the National and State Programme Headquarters.

There are three options available for purchase and distribution of bednets up to district level. These are: **a.** Bednets are procured by the Dte. of NMEP and sent directly to DMO as in the case of supply of insecticides, **b.** The Centre gives cash grants to the States or State level societies under the chairmanship of Health Secretary who may purchase the bednets and send to DMO, **c.** The Centre sends the money directly to district level societies under the chairmanship of District Collector or Zila Parishad Chairman who may purchase the bednets for distribution to the periphery.

Use of Medicated Bednets

It is to be ensured that all the members of household use the impregnated bednets. IEC should be intensified till the inhabitants use the bednets regularly. It should also be emphasised that when the people sleep outside the house or in the verandah, they must continue to use the bednets. High risk persons like infants, children and pregnant women should be persuaded to use the bednets at the earliest possible time after sunset.

Suggested Areas for Pilot Trials

Taking into consideration the malaria incidence, socio-cultural aspects of people and health infrastructure, it is suggested to take up pilot studies initially in the far flung areas of the seven North-Eastern States and some selected areas in Eastern Uttar Pradesh, Bihar, West Bengal and peninsular Indian States like Maharashtra, Gujarat, Andhra Pradesh, etc., which could be extended to other areas subsequently after evaluating the initial pilot trials.The total popukation to be covered under IIDN couold be around 5 million during 1997-98

Phasing Out the Use of BHC and DDT in the National Programme

In view of persistence of organochlorine insecticides like DDT in the environment and bio-magnification of the insecticides in non-target organisms including man, it has been decided by Govt. of India to phase out the use of DDT and BHC in the National Programme.

The tentative use of insecticides for protection of population under NMEP during the next five years is given in Table-7.1.

The tentative projection of population to be protected from malaria and kala-azar transmission will be finalised every year after reviewing the incidence in the preceding years. It is seen from the Table - 7.1 that the use of DDT will be reduced gradually. By the end of next five years the reduction in the use of DDT will be 64%. It will be further reduced to cover 10 and 5 million population in the successive years (i.e. 2002 - 2004) and it is proposed to ban the use of DDT from 2005 onwards.

The use of BHC is likely to be banned by the year 1999. Though originally BHC was proposed to be banned by 1997, its use for two years more has been projected so that alternative strategy will be developed before total ban is imposed. Lindane spray will be used in areas where BHC spray will be withdrawn.

The use of Lindane will be limited to cover a maximum population of 20 million from the third year and its use in the programme will be decided after evaluating the field data in the first two years. The population to be covered will be 5 million in the first year and 10 million in the second year. BHC and Lindane are considered to be of limited value for malaria vector control.

Table-7.1. Tentative Projection of Population to be Protected under Chemical Insecticides (Pop. in Million)

Insecticide	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002
DDT	54	50	40	40	20
BHC	25	10	Nil	Nil	Nil
Lindane	5	10	20	20	20
Malathion	18	18	18	18	18
Synthetic Pyrethroids	48	48	48	48	48
Malaria (Total)	150	136	126	126	106
Kala-azar (DDT)	48	40	26.6	26.6	14
Synthetic Pyrethroid Impregnated Bednets	5	15	35	50	50

Note :- The above table is only one of the examples of various options that can be considered for Residual Insecticidal spray for the vector control.

The use of malathion (25% wp) is tentatively fixed to cover 18 million population per year for the next five years. Similarly the use of synthetic pyrethroids is projected to cover 48 million per annum for five years. Malathion and synthetic pyrethroids will be used in areas where the vectors exhibit double or triple resistant to conventional insecticides respectively.

The total population to be covered under indoor residual spray to control malaria will be gradually reduced from 150 million in 1997-98 to 106 million in 2001-2002. Similarly in Kala-azar control, the population to be covered under indoor residual spray will be reduced from 48 million in the first year to 14 million in the fifth year.

The use of insecticide impregnated bednets (IIBN) will be increased gradually to cover those areas where the indoor residual spray will be withdrawn. During the five year interval the population to be brought under IIBN will be gradually increased from 5 million to 50 million.

The manufacturing firms in the country will be able to meet the requirements of the programme. There will not be any need to import insecticides from abroad. The DDT and BHC manufacturing units in the country will have to take steps to convert their plants for production of alternative insecticides/pesticides.

SECTION-2
STRENGTHENING OF NMEP AT NATIONAL, REGIONAL AND STATES LEVELS

NMEP AT NATIONAL HEADQUARTERS

Infrastructure Development

The existing manpower at the Directorate of National Malaria Eradication Programme and the Regional Offices for Health & Family Welfare (ROH & FW) need to be strengthened for effective implementation and monitoring of the accelerated Malaria Action Programme (MAP) throughout the country. Besides augmenting manpower, the Dte. of NMEP is to be strengthened in terms of infrastructure like building with requisite facilities for conducting training, holding workshops, seminars and meeting of technical committees and State Programme Officers. Proper laboratory facilities are needed for Central Cross-Checking Organisation and well equipped practical - demonstration rooms for malaria microscopy and entomology training.

Research and Training Division

The Research and Training Division at the Dte. of NMEP requires to be strengthened as it will be advantageous in monitoring and coordinating the training programme and undertaking need based research which is of utmost importance amidst the diversity of eco-epidemiological situation. The basic activity of the division shall be planning, monitoring and evaluation of training and research programme in malaria, filaria, kala-azar, Japanese encephalitis, dengue/dengue haemorrhagic fever, etc. To conceive, co-ordinate, execute and evaluate operational studies, it is imperative that a Public Health Specialist in the rank of Joint Director be appointed. He will be responsible to plan and coordinate the work of *P.falciparum* monitoring teams at Hqrs, Regional and State levels. He will also plan and execute operational research, evaluate and provide consultancy services.

At present there is no training component in the Dte. of NMEP. The In-depth Evaluation Committee-1985 observed that malaria training being provided to the technical personnel was inadequate in respect of course content and insufficient in the number of trained personnel to meet the needs of the programme and there was need to strengthen training at all levels. The Expert Committee opined that there should be training at National as well as State levels to provide in-service training in malariology.

Problem of Drug Resistance and its Monitoring

Drug resistance problem has been slowly increasing year after the year as indicated in Chapter-3, Section-4 and regular monitoring of drug resistance is an indispensable component of the programme as long as there is malaria transmission. Development of resistance is inevitable since it is a biological phenomenon and it is essential for the programme to monitor the sensitivity of the parasite to the drugs used in the programme so that the alternative therapy could be introduced whenever drug resistance phenomenon to the conventional drugs precipitates. In view of the problem, the States should also monitor drug resistance regularly in all the endemic areas. Besides continuing the existing 13 *P.falciparum* monitoring teams, four more additional teams should be created to impart training to the State teams and also monitor drug resistance independently.

Health Management Information System: (HMIS)

Timely reporting plays a pivotal role for the successful operation of any control programme. The monthly technical reports from the districts and States are received at NMEP Hqrs two to three months behind schedule. Malaria being an acute disease which rapidly spreads, immediate corrective measures are to be undertaken. Simple, accurate, appropriate and concise reporting system should be developed for instituting timely corrective measures. For early reporting, NMEP need to be hooked to National Informatics Centre (NIC). All the States have been provided with fax

machines for faxing basic information at the conclusion of every calendar month, with a follow-up detailed report through normal channel. Further, the district authorities also are instructed to feed basic data pertaining to malaria every month through NIC NET, which can easily be retrieved/utilised by the concerned organisations.

To meet the above demands, the computer cell needs to be strengthened. A computer programmer for monitoring the programmes of malaria, filaria, kala-azar and Japanese encephalitis should be created at the national programme headquarters.

Since the district-wise information received from 32 States/UTs is voluminous in magnitude and immediate compilation and collation are important, a post of Statistical Investigator should also be created for scientific interpretation of data for needful follow-up action.

Restructuring of Division of Logistics and Accounts

NMEP continues to be one of the major health programmes in the country with an annual expenditure of about Rs. 180 to 200 Crores. The major component of the budget is spent on material & equipments. At present accounts, budgeting, monitoring of expenditure, logistics and administration are looked after by a technical officer. The Dte. of NMEP is not provided with a regular post of finance controller and to cope with the herculean task which is likely to be overloaded when more external assistance will flow into programme, a senior level post, preferably in the rank of Deputy Director (Finance, Admn. & Logistics) should be created with responsibility to look after accounts, budgetary matters, administration and procurement procedures. Such a post will be extremely useful in streamlining budget performance and procurement procedures.

Consultant Services

In additional to regular posts suggested above, temporary consultancy services of experts in the relevant fields will have to be engaged on six monthly basis and renewable at six monthly intervals to guide the programme and cope with the additional work especially on account of special projects with external assistance. The consultants will be Indian Nationals and they will have to report directly to the Director, NMEP and work under the supervision of a regular senior officer of the Dte. of NMEP. The contract can be terminated with one month written notice.

a. Decision Systems and MIS Specialist

The responsibilities of the consultant will be, **i.** to evaluate management steps in relation to information collected at national, state and district levels on malaria control and **ii.** to develop operational plans for geographical information systems, including consultative group on MIS and GIS.

b. Procurement and Budget Specialist

The responsibilities of the consultant will be, **i.** to prepare detailed budget and procurement documents, **ii.** to act as liaison with procurement units of external donor agencies, including training, procedures and other related matters, **iii.** to make standard expenditure statements and **iv.** to administer the preparatory budget for workshops, consultancies and other related activities.

c. Two Public Health Specialists

The responsibilities of two consultants will be, **i.** to assist in all technical components of project formulation, especially for newer components, **ii.** to assess readiness and details of initial district action plans, **iii.** to develop details of Project Implementation Plan, **iv.** to develop background material for Project appraisal including structure and content of Annual Programme Development Reviews, **v.** to evaluate results of specific reports on MIS, IEC, medicated mosquito nets and integrate these into project planning. One person would be exclusively responsible for intersectoral collaboration, and **vi.** the person would report directly to the Director, NMEP and work under the supervision of the Project Coordinator.

d. Communication and IEC Specialist

The responsibilities of the consultant will be, **i.** to prepare detailed IEC strategies and documents including media campaigns and materials, **ii.** to advise central and district level IEC campaigns on

appropriate equipment and other purchases, including liasion with procurement officer, **iii.** to act as liasion with other agencies, such as CHEB and NGOs, etc. on IEC approaches and strategies, **iv.** to evaluate preliminary IEC efforts at state and district levels and **v**. the person would report directly to the Director, NMEP and work under the supervision of the Project Co-ordinator.

e. Economist

The responsibility of the consultant will be to undertake, **i.** cost-analysis, **ii.** cost-effectiveness of each component in the projec, **iii.** cost-benefit of the entire projec, **iv.** to monitor and guide the inputs and outcome on the financial aspects on various components of the project.

f. Project Assistant / Data Entry Staff

The responsibility of the project assistant will be **i.** to assist staff in Preparation Unit with secretarial work including typing of documents, entry of data and general support functions, **ii.** to answer phone calls and general quarries and to arrange deliveries of documents and **iii.** the person would report directly to the Director, NMEP and work under the supervision of the Project Coordinator.

g. Requirement of Equipments and Vehicles

i. Purchase of three computers, including two desktops and one laptop. Specifications: 486 speed, min. 200 MB hard drive, 4 MB ram, carrying case. Total cost Rs. 1.5 Lakh each, total = Rs. 4.5 Lakhs (including service contract).

ii. Purchase of laser printer, HP standard, 300 dbi. Total cost Rs. 50,000 (including paper supply and service contract).

iii. Purchase of vehicle, Ambassador for transport of Preparation Unit staff to meetings, delivery of documents and other support services. Total cost Rs. (3.0 Lakhs, including service contract). Additional costs for maintenance at Rs. 1,000 per month

STRENGTHENING OF REGIONAL OFFICES FOR HEALTH & FAMILY WELFARE (ROH & FW)

All the ROH & FWs except the regional offices at Trivandrum and Shimla need to be strengthened by providing a post of one Research Assistant each at the 15 ROH & FWs in the country. The responsibilities of Research Assistant will include supervision of the activities in the field especially the work of Field Workers, Lab-technicians and Insect Collectors engaged in research activities. Research Assistants will also be responsible for imparting training to PHC Lab. Technicians and Insect Collectors as well as cross-checking the work of microscopists at different places including ROH & FW.

STRENGTHENING OF STATE NMEP PROGRAMME

1. IEC Expert

Since community will be actively involved in the accelerated malaria action programme, the IEC components will be strengthened at the State Programme Headquarters and District levels. Wherever IEC experts are not in position, the States should create requisite posts of IEC specialist to give impetus to the programme implementation. Adequate budgetary provision should be made to produce IEC materials and disseminate the messages through multi-media.

2. District Mobile Epidemic Control Teams

As mentioned in the Operational Manual for Malaria Action Programme, every district in the epidemic prone area will have mobile epidemic control unit comprising the following :-

Equipments		Staff	
i. Vehicle (Van)	- 1	i. Medical Officer	- 1
ii. Microscopes	- 2	ii. Technicians	- 2
iii. H.C.Sprayers	- 5	iii. Spraymen	- 5
iv. Hand operated micro-discharge fogging machine	- 1	iv. Insect Collector	- 2
or Atomizers	- 5	v. Driver	- 1
v. Insecticides	- As required		
vi. Chemicals	- do		
Drugs	- do		
Glassware, etc.	- do		

3. Zonal Entomological Teams

The entomological monitoring requires to be intensified by the 72 Zonal Entomological Teams. The Zonal Teams are to be shifted to the highly endemic places wherever required and districts are to be reallocated taking into consideration the malaria morbidity and mortality. The sanctioned staff should be full in position and an independent vehicle shall be kept exclusively for entomological monitoring. The entomological data collected by the Zonal Team shall be closely scrutinised for undertaking needful changes in the strategy wherever warranted.

SECTION-3
PROCESS INDICATORS IN MALARIA ACTION PROGRAMME

The NMEP will adopt a process-based approach in which specific implementation will be based upon **a.** specific and well prepared district level plans, **b.** new NMEP procedures and **c.** on-going formal evaluation of inputs in due course of time from a provider of malaria control services to a facilitator, regulator and financier for more focal activities carried out by public, private and voluntary sectors.

The Dte. of NMEP has developed process indicators for specific evaluation. These will be useful to link specific procurement schedules to plan implementation of different components. Flow charts indicating decision making pathways for each component and flow charts showing flow of evaluation of NMEP procedures have been developed.

The indicators are subject to change depending upon the epidemiological pattern of the diseases and change in implementation policy accordingly.

Table- 7.1 **COMPONENT: EARLY DIAGNOSIS AND PROMPT TREATMENT (EDPT)**

BASIC OBJECTIVE :- Early case detection and treatment facilities to the population.

LEVEL OF IMPLEMENTATION	PROCESS	SUB PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	ACTIVITIES TO BE UNDERTAKEN (Operational aspects)	ASSESSMENT PARAMETERS	RISKS
1. Village (1000 Population)	Fever Case Treatment (FCT)	- Drugs availability - appointment of DDC s/FTDs	DDC/FTD/MLW	I) Panchayat II) PHC-MO III)Malaria Assistant	I) Distribution of drugs to fever cases ii) collection of slides from fever cases in numbers.... iii) referral	-Availability of drugs at DDC/FTD (50 tablets) - DDC/FTD within 3 kms walking distance -10% of population in fever utilise the services of DDC/FTD.	turnover of DDC/FTD
2. Gram Panchayat (2-3 villages appx 2000 Population)	FCT	- Drugs availability - appointment of MLW	MLW/MPW	- Panchayat - PHC - MO - Malaria Assistant (Samiti at village level)	(I) + (ii) + (iii) (iv) Take slides to PHC within a week. (v) replenishment of drugs to DDC/FTD (vi) collaborate MPW (vii) inform PHC of increase fever incidence (viii)transmit info .on treatment seeking behaviour	- availability of drugs at MLW (150 tablets) - 1 MLW for each Gram Panchayat - no. of visits to PHC in 1 month (minimum 4) - no. of interaction with DDC/FTD (minimum 4) - no. of clean slides ,(minimum 10), needle	turnover under local influence .likely overlap between MLW; MPW and FTD
3. Subcentre (3000-5000 Population)	FCT	- Drugs availability	MPW	- PHC-MO - Panchayat - Malaria Assistant	i) Active surveillance ii) Contact DDC/FTD/MLW iii) give RT iv) Report high fever incidence. v) Supervision of work by Supervisors vi) training for ensuring quality of service and quality of supervision	- Maintenance of ABER in respect of 10% of target population Frequency of visits - No. of RT given	- Multifarious responsibilities ,may not take much interest in the Project.
4. Primary Health Centre (PHC) (20,000-30,000 Population	-Diagnosis -Treatment of uncomplicated ,complicated and severe malaria - referral - Malaria reporting	- Microscopic examination of slides. - Diagnosis by Rapid diagnosters - Correct diagnosis of severe and complicated malaria. - Knowledge of malaria cases to be referred - skills & knowledge to analyse malaria situation village wise.	- LabTechnician - PHC-Mo	CDMO D.Mal.O Zilla Parishad	- Slide examination & reporting - Complete treatment to the case. - Treatment of severe & complicated malaria cases - Look for signs in a case to be referred --Maintenance of registers,reports and warning of any rise in malaria incidence - Drug Treatment failures	- examine 60-70 slides a day - cross checking of slides - Diagnosis & treatment of malaria cases (uncomplicated & complicated) - Stock of injectable anti malarials - Maintenance of registers	- absence of Lab. Technician may lead to backlog. Necessary that all the persons may be trained in malariologu - Training of doctors for correct treatment of malaria.
5. Community Health Centre (CHC) (100,000 Population)	-do-	-do-	Physicians Lab. Technicians.............	Zilla Parishad CDMO/DMO/Medical Suprintendent	-do-	-do-	-do-

6. District a) District Hospital / DMO	- Diagnosis & treatment of malaria (complicated & uncomplicated)	- Diagnosis by microscopy or by dip stick method - Treatment of severe & complicated malaria.	Physicians	CDMO/DMO/Zilla Parishad State	- Slides examination of OPD and admitted cases of malaria - Priority admission of severe & complicated cases - Correct treatment of S & C malaria -reporting -do-	- slide examined for fever cases - no. of severe & complicated cases admitted - no. of deaths/recovered/etc.	—
b) Private Practitioner & Hospitals	-do-	-do-	-do-	PMA/IMA —	Quality of care provided..		- May not report malaria cases. Involvement of PMA /IMAfor correct treatment of malaria.
c) Government Dispensaries (under various departments)		- microscopy - rapid test -correct time for referral	-do-	executing agency	as in above		-do-
d) Hospitals under Railways, Defence, telegraphs, etc.	- Diagnosis & treatment of malaria - referral - reporting	-do-	-do-	chief of the Hospital	- Slide examination & complete treatment to +ve cases		- -do- -
e) Industrial Establishments	- Diagnosis & treatment of malaria - referral - reporting	........do......	.......do....	..........do........	- reporting -do-	linkages between the different hospitals Technical guidance from NMEP	——
f) Urban	.....do... - Diagnosis & treatment - referral - reporting	- do-	- Microscopy centre for every 20,000 Population - NAO's	Municipal Health Officer	-do-	No, of slides examined -do- Provision of microscopes and drugs by NMEP -do-	
g) Institutions and development areas	- Diagnosis & treatment - referral - reporting	- do-	- Community (acting as distribution centres) Microscopy for each establishment	MO	- do -		

Table- 7. 2 **COMPONENT :** EARLY DIAGNOSIS AND PROMPT TREATMENT (EDPT)
SUB-COMPONENT :DRUG DISTRIBUTION SYSTEM

LEVEL OF IMPLEMENTATION	PROCESS	SUB - PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETERS	RISKS
CENTRE	- Drug indent	(i) calculation of Drug requirement depending on malaria endemicity	Director, NMEP	NMEP	i) Assessment of malaria situation ii) Quantity of Drug required iii) Type of Drugs	timely indents	
	- Drug Purchase	i) Tender ii) Ordering iii) Procurement	Director, NMEP, MSO/DGHS MOH a FW	NMEP	i) Advt in papers ii) Opening of tenders by purchase committees iii) Selection of firms iv) Placing orders & specifying quantities	timely purchase	
	- Drug storage	Receiving of drugs & storage	Director, NMEP MSO/DGHS	NMEP, MSO	Storage of stocks	proper storage	
	- Drug supply		Director, NMEP MSO/DGHS	NMEP,MSO	Centre to State	sufficient stock	
	- Drug Quality Control		NMEP	NMEP/SEARO,WHO	q.c.checks	checking/testing	
State		Sending the drug	Jr. Director/DHS	State	State to District	assessment of excesses and shortages at each level	
District		-do-	CDMO/DMO	District	District to PHC		
PHC		-do-	PHC-MO	PHC	PHC to Subcentre/Gram panchayat -community -DDC/FTD		
Subcentre			MPW	Subcentre	Subcentre to Community -Gram panchayat		
Gram panchayat			MLW	Gram panchayat	Gram panchayat to Community -DDC/FTD		

Table- 7. 3 **COMPONENT :** INTEGRATED VECTOR CONTROL
SUB-COMPONENT : INDOOR RESIDUAL SPRAYING (IRS)
Basic objective: decrease transmission potential

Level of Implementation	Process	Sub- Process	Implementor	Institution responsible for Implementation	Operational activities	Assessment Parameters	Risks
District/State	IRS	-Planning through selection criteria for selecting villages and insecticide, their volume, logistics	DMO/MO-PHC	DMO/CDMO	-deciding on the criteria for selection of villages -deciding on the criteria for selection of insecticide -actual selection of villages	- Availability of a good and operational MIS -epidemiological records on village basis -data analysis & interpretation capabilities	
District		- Preparation	DMO/MI/MO-PHC	DMO/CDMO MO-PHC	-Man, material and time schedule of spraying operation - spraying of houses	TPM	
District/PHC		-Implementation	Spray squads	- MI/MO-PHC, DMO/CDMO	periodical field supervision	quality and Percentage covered	
District/PHC		- Supervision/ Monitoring	DMO/MI	MI/MO-PHC -DMO/CDMO	-Filling up of forms Consolidation Analysis of the reports	within the time frame --------- supervision capabilities	
District/PHC		-Reporting	-Squad leader -MI -DMO	MI/DMO			
District/PHC		-Assessment	MO-PHC/MI, DMO/CDMO	MO-PHC/MI, DMO/CDMO			

Table-7. 4 **COMPONENT:** INTEGRATED VECTOR CONTROL

SUBCOMPONENT: MEDICATED MOSQUITO NETS (MMNs)
BASIC OBJECTIVE: DECREASE MAN-MOSQUITO CONTACT AND REDUCE TRANSMISSION

Level of Implementation	**Process**	**Sub-Process**	**Implementor**	**Institution Responsible for Implementation**	**Operational activities**	**Assessment Parameters**	**Risks**
District/PHC	-Needs Assessment -Selection of areas in phased manner -Demand Generation	-finalization of supply plan & logistics -vector bionomics -changes in human behaviour thro' community participation thro' dynamic IEC	PHC-MO/MI, DMO/CDMO Panchayats, DSW.	DMO/CDMO, Zilla Parishads/ Tribal Development Authority	finalization of the numbers and sizes of MMN s	Data on numbers of households their sizes, sleeping habits,and number of MMN s required, based on research - SA etc	
	ii) Preparation of area	- GR of the area - target audience need focussed & behaviour change objective focussed communication efforts	- Link worker - other village level functionaries working collaborativey for the project	Panchayats, DMO/CDMO, PHC-MO/MI, Dte NMEP/State	- Calculation of requirement of bednets - assessment of purchasing power of the target groups for bednets - Motivation for use of bednets	Availability of information and socio-economic factors determining the acquirement of MMNs by the target families in the area	
	iii) Procurement of Bednets	Purchase at district level by quotation basis/Central procurement	District Malaria Committee (DMC)	(DMC)	- DMC members will make the purchase from the local market if procured locally	-availability of MMNs - their adequacy - their quality/suitability - information on preference pattern of the community	

Level of Implemention	Process	Sub-Process	Implementor	Institution Responsible for Implementation	Operational activities	Assessment Parameters	Risks
	iv) Distribution	-Transportation of bednets to PHC - From PHC to village - Village to Consumer	DMO - Link worker /Mahilla Mandals/ AWW -do-	DMO/CDMO/ Zilla Parishad/TDA - PHC-MO/ Gram Panchayat/ Village Samitis -do-	Distribution, Scheduling , Recording	- No. of bednets per family in terms of different options expressed - % of population provided bednets	
	v) Social Marketing						
	vi) Initial Impregnation of Bednets	- Availability of insecticides & materials - Training to community	DMO/CDMO,P HC-MO - DMO/PHC-MO, Link worker, AWW, MM	-do- DMO/CDMO, PHC-MO	Impregnation, Supervision		
	vii) Use of Bednets	Follow-up monitoring on actual use Periodic	Link worker, Panchayat, MM,DMO-CDMO/PHC	-do- -do-	Periodical Survey	% of community using bednets based on info. gathered thro' follow-up studies	
		summary					
	viii) Reimpregnation of Bednets	Social marketing of insecticides to encourage better coverage	MLW,AWW,MM, Community	-do-	Close Followup		

Table-7. 5 **COMPONENT: INTEGRATED VECTOR CONTROL**
SUB-COMPONENT: BIOLOGICAL CONTROL
BASIC OBJECTIVE : To reduce the breeding potential

LEVEL OF IMPLEMENTATION	PROCESS	SUB- PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETERS	RISKS
District/Sub district level/PHC	i) Larvivorous fish	- Hatchery development	Zilla parishad/DMO, CDMO/MO-PHC/ Malaria Assistant/ Link worker	District Malaria Committee (DMC)	· Funds from DMC to develop hatchery	No: of hatcheries in a district	
		-Transportation of fishes from hatchery to place of release	MI/Link worker	PHC/Gram sabha/ village samitis	- Fish to be transported in polythene packets	No: of ponds/check-dams having larvivorous fishes	
Urban Areas	ii) Bt.	-experimental use first of cheaper chemical larvicides(temephos) in order to determine if it works; then and if so, -Introduction of Bti or Bs - Monitoring of Bti or Bs	CDMO-DMO/State /Dt NMEP/MRC	CDMO-DMO/State /Dt NMEP/MRC	------	------	

Table-7. 6 **COMPONENT** : PREVENTION AND CONTROL OF EPIDEMICS

SUB- COMPONENT : EARLY WARNING SYSTEM
Basic Objective: prevention of epidemic outbreak

LEVEL OF IMPLEMENTATION	PROCESS	SUB- PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETER	RISKS
District level	-Analysis of existing data on previous epidemics	- Collection of data from various sources -Compilation of data - Analysis	MO-PHC, DMO	DMO-CDMO	- 10 year data to be studied and analysed for factors which led to epidemics in the past	Availability of the needed 10yr data	----
District/State NMEP	- Identification of epidemic prone areas bv GIS	TPP	MO-PHC,DMO, Jt. Dir (Mal), Dir, NMEP	DMO-CDMO, Jt. Dir. , NMEP	This will follow from the above	Availability of GIS	----
-do-	- Identification of pre-epidemic factors	-TPP - epidemiological - ecological - socio-economic factor - climatic	-do-	-do-	This will follow from the above	Based on past trends, analysis of observed indications -availability of a good MIS	-------
-do-	- development of early warning system	- all possible factors	-do-	-do-	This will follow from the above	establishment of EWS & its operationalization	----

Table- 7. 7 **COMPONENT:** PREVENTION AND CONTROL OF EPIDEMIC
SUB-COMPONENT: PREVENTION OF EPIDEMICS
Basic Objective: To prevent occurrence of epidemic outbreak

LEVEL OF IMPLEMENTATION	PROCESS	SUB-PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETER	RISKS
District	Prevention of epidemics	-establishment and use of EWS -immediate interventions to prevent occurrence of outbreaks	DMO-CDMO, MO-PHC	DMO,CDMO, MO-PHC	-detection of pre-epidemic factors -taking prompt preventive actions e.g. opening of malaria clinics, source reduction, dynamic communication to people for info. and behaviour change	Monitoring system is existing along with a good and reliable EWS	---

Table- 7. 8 **COMPONENT:** PREVENTION AND CONTROL OF EPIDEMICS
SUB-COMPONENT: CONTROL OF EPIDEMICS
Basic Objective: To combat maiaria outbreak

LEVEL OF IMPLEMENTATION	PROCESS	SUB-PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETERS	RISKS
District	- Control of epidemic	- Analysis of TPP - degree and severity of epidemics - determining control measures based on data assessment	DMO-CDMO/ MO-PHC (Epidemic preparedness committee)	DMO-CDMO/ MO-PHC/State	- Mass blood examination -Drug administration -Entomological survey -IRS (synthetic pyrethroids) -Establishment of temporary malaria clinics -a dynamic communication programme to inform and motivate community for active participation in control activities	-Assessment capability of the different -dimensions of epidemic -of control operations and determination of actual plans -monitoring impact -management skills relating to control operations	

Table- 7. 9 **COMPONENT :** INSTITUTIONAL AND MANAGEMENT CAPABILITY

SUBCOMPONENT: TRAINING

Basic Objective: Manpower development and project strenthening

SL NO	LEVEL OF IMPLEMENTATION	PROCESS	SUB PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETER	RISKS
1	PHC	Training of DDC/FTD MLW 7,50,000 persons to be trained in 25,000 batches with 30 participants in each batch - over five years	-setting up of training teams - trainers' training - curriculum development - preparation of training materials - preparation of training calendar - planning physical infrastructure needed - getting necessary sanctions, administrative & financial - running the actual training - monitoring of training - feedback from trainees from field - assessment of impact - that forming an input for a new TNA	MO-PHC	PHC/CDMO/DMO	-selection of trainers -training them with help of Master Trainers identified for the purpose -organising curriculum development workshops -production of training materials -fixing physical facilities for training -day-to-day management of training -provision of training aids - arrangement for site visits - arrangements for practicals - management of monitoring, feedback, and assessment of impact	-Every year 1.50,000 are to be trained in 5000 batches - availability of training management capabilities - availability of training calendar - availability of the needed funds availability & use of output parameters	Vacancies at grassroots level are to be filled on priority and more posts are to be created in some state as per norm in NMEP training may not focus on the actual performance requirements in terms of building the needed capacities trainers' training may not focus on the perceived needs of trainees from an operational point of view
2	PHC	Training of 1,50,000 MPWs in 6000 batches over five years with 25 participants in each batch	-do-	MO-PHC	PHC CDMO/DMO	-do-	-training of 30,000 persons every year in 1,200 batches -availability of training management capability as detailed above availability and use of output parameters	Vacancies of MPWs are to be filled in al' subcentres and new posts are to be created in some states as per norm of NMEP -This may not happen always or is likely to be delayed - The other alternative of transferring MPW's from other areas of the state and filling up vacancies in project areas may not fructify due to workers' unwillingness to move to project areas, most of them being tribal areas
3	Zonal Regional State	Training of Lab. Technicians - 25,000 in 1000 batches with 25 participants in each batch - over a period of five years	-do- .	Zonal Officer, Regional Director/ State Malariologist	ZONAL OFFICE RFPTC ROH & FW & CML	-do-	Every year 5000 are to be trained in 200 batches - availability of training management capability as detailed above availability and use of output parameters	A few vacancies that exists in some states are to be filled . Some more malaria clinics are to be established in high risk areas - quality of training may not be ensured

SL NO	LEVEL OF IMPLEMENTATION	PROCESS	SUB PROCESS	IMPLEMENTOR	INSTITUTION RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETER	RISKS
4	Zonal/Regional/State	Training of Supervisory staff/ Malaria Inspectors -25,000 numbers to be trained in 1000 batches with 25 participants in each batch over five years	as in same col.. above	Zonal officer . Regional Director/ State Malariologist	ZONAL OFFICE RFPTC ROH & FW/ & CML	-do-	Every year 5000 are to be trained in 200 batches -availability of training management capability as detailed above availabilty & use of output parameters	The trained persons may not get retraining within a period of three years
5	ROHFW/Med :al colleges/ State Training institute	Training of MO-PHC - 1000 batches in five years at 25 participants per batch	-do-	Regional Director/ Dean of Medical College/ State Malariologist	ROHFW/ Medical College/ State Training Centre	-do-	Every year 5000 are to be trained in 200 batches - availability of training management capability as detailed above availability & use of output parameters	non-creation of new PHCs as per the norm of Govt. of India in some states
6	Central Malaria Laboratory or equivalent	Training of a total number of 1875 District level officers/DMO/ Dy. CMHO,etc- 75 batches with 25 participants each over five years	-do-	Director of NICD*, Director of MRC* and Joint Director of IVCZ*	NICD/MRC/IVCZ	-do-	Every year 375 are to be trained in 15 batches - availability of training management capability as detailed above availability & use of output parameters	The States may run into problems in sponsoring the required number of participants for every training course
7	National and State Identified Institutions	Training of Zonal Entomologists/ Biologists of UMS-500 to be trained in 20 batches of 25 participants each over five years	-do-	Director of NICD, Director of MRC and Joint Director of IVCZ	NICD/MRC/IVCZ	-do-	Every year 100 are to be trained in 4 batches : availability of training management capability as detailed above availability & use of output parameters	The States may run into problems in sponsoring the required number of participants for every training course

SL NO	LEVEL OF IMPLEMENTATION	PROCESS	SUB PROCESS	IMPLEMENTORS	INSTITUTIONS RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETERS	RISKS
8	National	Training of Trainers (TOT)	-Identification of suitable master trainers/master training institution(s) -Needs Assessment & Curriculum Development for orienting them to the new elements of the control strategy as proposed under the project - Ensuring that the trainers will focus only on the performance requirements of project related work - Planning the management of training with tools like (working out) the training load and preparation of training calendar - Actual running of the programme -Assessment of its effectiveness	Director of NICD Director of NMEP and other Training resource persosns/institutions	NICD/NMEP	-Formation of a Training Advisory Committee -Selection of Master Trainers/Training Institution(s) -Quick assessment of their training needs -Curriculum development based on the above -Implementation of orientation training to the Master Trainers/Institution(s -Assessment of its effectiveness	-Every year 50 are to be trained in 2 batches - Availability of training management capability - availability and use of output parameters	Master Trainers/Institution (s) selected may not be the right choice
9	National/State	Conduct of 100 Workshops over five years period for intersectoral coordination for Bio-Environmental Care	-Identification of Participants - Corresponding with the respective authorities for sponsorship - Needs assessment -finalization of subjects for discussion -Identification of Resource Persons & orienting them to the new elements of the control strategy proposed - Preparation of Training Calendar Implementation of the workshops -Assessment of their impact	Director of NMEP, Director s of Health Services of the States	NMEP Centre and NMEP States & other sectors	-identification of participants -getting their sponsorships -planning and carrying out needs assessment -development of subject matter for disccussion -planning physical facilities and support audio visuals -preparation of reading materials -planning site visits -obtaining services of resource persons -briefing them -actual running of the workshops -assessment of their impact -using the results of assessments for future workshops	-Every year 600 are to participate in 20 workshops of 30 participants in each -Availability of workshop management skills availability and use of output parameters	Getting sponsorships from all the sectors may pose problems -The NMEP/MOH. may find it difficult to prevail upon all the sectors responsible for creating mosquitogenic conditions in favour of ensuring that the concerned sectors actually implement the resolutions and outputs of the workshop

* NICD = National Institute of Communicable Diseases, Delhi
MRC = Malaria Research Centre, Delhi
IVCZ = Institute of Vector Control and Zoonosis, Hosur, Tamil Nadu

Table- 7. 10 **COMPONENT: INST. AND MANAGEMENT CAPABILITY (I&MC)**

SUBCOMPONENT: INFORMATION, EDUCATION, COMMUNICATION (IEC)

Basic Objective: Community, community leaders, etc. awareness of malaria control

LEVEL OF IMPLEMENTATION	PROCESS	SUB- PROCESS	IMPLEMENTORS	INSTITUTIONS RESPONSIBLE FOR IMPLEMENTATION	OPERATIONAL ACTIVITIES	ASSESSMENT PARAMETER	RISKS
Centre	- To inform, educate, and bring about behaviour promotion in the target population in coping with malaria and in cooperating with the control efforts undertaken under the project	-Commissioning of Formative Reserach in order to understand the communication needs and with a view to developing a suitable strategy- - -Decentralising such studies according to identified geo-ethnic areas under the project -Special focus to be kept on study of traditional media and their potential for project communication -Special focus again on compilation of locally relevant dialects, idioms, and symbols for suitable adoption in the communication materials -Special focus again on efforts by competent persons to carefully attempt message integration in the selected traditional media taking care not to destroy their structures or main storylines - Exploration of the possibilities of using ritualistic media particularly in backward rural and tribal areas -Planning and executing the production of mass media for consumption by educated and urban and peri-urban audience - Dissemination of mass media materials -Assessment of impact in terms of observed behaviour changes in the target population	NMEP IEC CELL,State/Director, NMEP/Director DAVP/CHEB/SHEB/ State I&P	NMEP IEC CELL,State/Director/NMEP/ DAVP/CHEB/SHEB/State I&P	- Formative Research Policy Guidelines - Policy Guidelines for print and other mass media - Policy Guidelines for folklore research, identification of traditional media, compilation of locally relevant idioms and symbols for communication, and message integration into main storylines of chosen traditional media -Policy Guidelines for impact assessment and its feedback for future use -Central production and distribution of certain items of : -posters, -booklets, -pamphlets -audio- visual aids	-Behaviour outcomes as a result of use of different media -Interpretation of assessments (dip-stick studies) and use the info. for modifying/changing the media mix and media contents -Availability of ability to focus on areas of resistance and to cope with the same through better and innovative advocacy efforts	-The traditional centralised approach to IEC may inhibit a proper appreciation of the need to decentralise health communication and the need for the use of locally relevant idioms and symbols in the media used for communication in rural and tribal areas in order to promote the desired behaviour changes in the target population—
State		-Responsibility for commissioning Formative Research and keeping special focus areas in such research as explained above	Jt. Dir(Mal)/CHEB/ DAVP/State HEB/State I&P	Jt.Dir(Mal)/CHEB/ DAVP/State HEB/State I&P	-Based on results of Formative Research to design, pre-test and produce print media materials , in local	do	do

		-Decentralised production of certain mass media materials in local language again keeping in view the need to use locally relevant idioms and symbols and the use of local dialects -Employment of specialists like folklorists for the above purpose Dissemination of the mass media - Assessment of impact of both mass media and other forms of communication like traditional media, and other group communication and inter-personal communication in terms of observed behaviour changes in the target population			languages - Based on Folklore Research findings, commissioning of message integration into main storylines of traditional media identified for the purpose -Actual use of locally relevant idioms and symbols in the production of various media materials at the local level -Assessment of impact and using the feedback for future productions		
District PHC		-Assistance to Formative Research -Assistance to Identification of traditional media - Assistance to folklore research like compilation of locally relevant idioms and symbols - Dissemination of media materials - Assessment of impact in terms of behaviour changes observed in target audience -Feedback	-DMO/Zilla parishads DHEO MCW,MPW, AWW,	Zilla parishad DMO-CDMO DHEO PHC-MO, Malaria Assistant	-Distribution of print media materials - Planning and implementation of traditional media -Planning implementation of other media like - Melas, and use of opportunities like shandies for communication -Assessment of impact and use of its feedback for future productions	do	do do
Village Level		-Implementation of the Communication strategy at the field level -Focus on inter-personal and group communication -Assistance to implementation of Traditional Media -Providing general support to mass media efforts at the village level -Feedback	MLW/AWW/Mahila Mandal Volunteers/Adolescent Girls of AWC Programme Panchayat members Other Village Youths	Panchayat AWC	-Planning the village level communication programme -Implementation -Feedback on impact	............do..........	

SECTION-4
BUDGET AND LOGISTICS

INTRODUCTION

The accelerated malaria action programme would be based on time-slice financing of enhanced inputs on a sectoral approach. While adopting the normal procedures of financial rules and regulations, the Directorate of NMEP will release the requisite resources to public, private and voluntary sections at State and district levels to implement an enhanced, community based and sustainable malaria control strategy. The sectoral approach will facilitate the programme to implement the selected strategy in targeted areas dependent upon malaria incidence, community preparedness and sustainability.

The different phases of Central assistance to the States/UTs for undertaking NMEP activities are detailed hereunder:

A. Centrally Aided Programme (1958-69).

B. Centrally Sponsored Scheme (1969-79).

C. Centrally Sponsored Scheme - Category- II (1979 onwards).

Procedure for Procurement at NMEP

The flow chart for procurement is given in Annexure- 7.1.

The comparative cost of Insecticidal spraying is given in Annexure- 7.2.

The comparative cost of larviciding is given in Annexure- 7.3.

A. NMEP as a Centrally Aided Programme (1958-69)

To start with, the NMEP in 1958 was a centrally aided programme. As per pattern the Government of India provided Central assistance at 50 per cent of the total annual expenditure till 1968-69 i.e. during II and III Plan periods as well as year to year planning during 1966 to 1969.

B. Centrally Sponsored Scheme (1969-79)

During the Fourth Five Year Plan the NMEP was made a Centrally sponsored scheme and as per pattern the Government of India used to reimburse the entire expenditure on NMEP to the States for 'Attack' and 'Consolidation' phase areas after deducting the committed level of expenditure incurred by the States during the NMCP in 1957-58 i.e. the last year of the Control Programme.

1. Committed Expenditure

In accordance with the above decision the committed liability of the various States/UTs was estimated by the Directorate of NMEP and it was worked out on the basis of the staff employed in Control Units, the expenditure, thereon based on the Central pay scales multiplied by the number of Units allotted to each State. However, at a later date, on detailed scrutiny, it was observed that many States could not raise all the Units allotted to them in 1957-58.

Thus their actual expenditure was less than what was estimated by the Directorate of NMEP on the basis of the formula indicated above. However, in view of the representations made by the States on the subject, the committed liability of the State Govts. was reviewed and in consultation with State final figures accepted by both State and Central Govts. were notified.

2. Pattern of Assistance

The pattern of assistance during IV plan period was:- **i.** 100% Central subsidy to the States/ Union Territories on operational cost, **ii.** Free supply of material & equipments to the States/ Union territories in kind, **iii.** The Central assistance to the States/UTs was limited to only Attack and Consolidation phase Units functioning under NMEP during the above period and **iv.** No

central assistance was being given on operational cost, material and equipments in respect of the Units which entered into Maintenance phase - thus the expenditure on Maintenance phase Units became the responsibility of the States out of their own resources.

3. The Basis for Release of Funds to the States/UTs

As regards release of the Central assistance to the States on account of operational cost, the participating States and UTs are being given subsidy of the operational cost incurred by them on the staff employed within the framework of the approved staffing pattern laid down by Govt. of India during IV Plan period.

4. The Method of Release of Central subsidy

The Central subsidy to the States/UTs is being released by 'ways and means' on the basis of the figures of actual expenditure furnished by the State Govts. duly verified by AGs concerned. Any excess or arrears that are due to or from States is adjusted in subsequent years, when the final figures are available.

5. Supply of material and equipments

As far as material and equipments are concerned these were procured by the Centre and were being supplied to the States/UTs free of cost during IV Plan period.

C. Centrally Sponsored Scheme - Category - II (1979- onwards)

During 1979-80, a major change in the pattern of Central assistance occurred due to the decision taken by the National Development Council to make the NMEP a Category - II Centrally Sponsored Scheme on 50:50 cost sharing basis between the Centre and the State Govts.

It was also decided that the Central Govt. shall provide against the above mentioned financial arrangement, initial allocation, to meet the expenditure on the following materials required under NMEP (rural and urban) according to the approved pattern. The procurement pattern during IX Five Year Plan will be as given below:-

Central Government	State Government
1. All imported insecticides/ anti-malarials/equipment (whether produced with foreign exchange or under any aid programme).	1. Operational cost on staff (Pay and allowances)
2. DDT 50% wp and part of BHC 50% wp from HIL and SPEC a Govt. of India undertaking	2. Malathion 25% wp from State sources
3. Larvicides like -Fenthion -Temephos -Paris green	3. BHC 50% wp from State sources
4. Diazinon	4. Mosquito larvicidal oil
5. Malathion Technical and Pyrethrum	5. Synthetic Pyrethroids
6. Synthetic Pyrethroids	6. Microslides
7. Antimalarial drugs	7. Microscopes
8. Microslides *	8. Vehicles
9. Microscopes *	9. Spray pumps
10. Vehicles *	
11. Spray pumps *	

* Centre will procure for UTs, NE States for tribal and hardcore areas, and the expenditure for the same will be met from external assistance.

The allocations of fund for NMEP activities in the States are initially discussed in the Working Groups of the Planning Commission. At this stage, the allocations for the States and the Central share are indicated and reflected in the following pattern:-

1. Plan allocations in respect of Central share are reflected in budget of Ministry of Health under NMEP, out of which, as indicated the procurement of insecticides, etc is done by the Central Govt.

2. In case of each State both the components of Central and State Plan allocations are indicated and included in the overall health plan ceiling of the States concerned. The States incur the initial expenditure on the items as already mentioned. The expenditure incurred on the supplies made to the States by the Central Government is communicated to the respective States and Accountant Generals for final adjustment against State Plan ceiling in the health sector.

3. 100% Subsidy for Expenditure on Malathion by the Centre (1983-84).

Under the above funding arrangement, some of the States due to financial constraints, could not purchase adequate insecticides for spray. Keeping in view the difficulties experienced by the States in procurement of the costly insecticide, Malathion 25% wp, Govt. of India in 1983-84 decided that the cost of the entire quantity of Malathion 25% wp would be met by the Central Govt. on 100% basis. The procedure was operative during 1984-85 also.

For the purpose of sharing expenditure on 50:50 basis, the following is taken into account.

i. The cost of insecticide supplied by the Centre or procured by the States for spray in Section with API - 2 and above in all areas irrespective of the phasing as existed before the introduction of the Modified Plan of Operation.

ii. Operational cost in respect of State headquarters and Zonal tier.

iii. Operational cost incurred on NMEP activities in erstwhile Attack and Consolidation phase areas which includes cost of District component, Surveillance component and spray staff.

Exception

a. Operational cost in respect of Maintenance phase areas the district and surveillance staff and the spray staff required for spray in areas above 2 API is not taken into account while computing expenditure on the NMEP activities, because the expenditure on Maintenance phase areas was made the States responsibility as far back as IV Plan period and this plan expenditure was taken into account by the subsequent Finance Commissions while considering devolution of total monetary resources from Centre to States. Thus in a way, this expenditure becomes a non-plan expenditure of the State.

b. The committed level, expenditure of the States as indicated under (B) (I) is deducted from the operational cost incurred by the States at the time of finalisation of accounts and rest of expenditure by State and Centre is pooled together for working out State and Central liability.

Methods of Release of Funds

The total expenditure thus incurred under NMEP operations taking into consideration the exceptions indicated above is pooled together and 50:50 sharing of the State and Centre is worked out.

Final adjustment

a. In case, the expenditure of the Central Govt. is more than 50% share so worked out, efforts are made to recover the excess amount from the State in cash.

b. In case the expenditure incurred by the States on various items of operational cost, purchase of insecticides, etc. is more than the Central expenditure incurred in respect of material and equipment supplied to the States, the balance so worked out is released to the States as cash subsidy.

NMEP - INDIA

	Estimated Expenditure (in Rs. crores)
NMCP	
Expenditure of NMCP (1953-54 to 1957-58)	24.00
Sub-Total	24.00
NMEP	
1. II Five Year Plan-NMEP started in 1958-59 to 1960-61	42.12
2. III Five Year Plan (1961-62 to 1965-66)	86.84
3. Annual Plans (1966-67 to 1968-69)	46.71
4. IV Five Year Plan (1969-70 to 1973-74)	74.21
5. V Five Year Plan (1974-75 to 1978-79)	213.46
6. Annual Plan (1979-80 (50:50 basis)	35.57
7. VI Five Year Plan (1980-81 to 1984-85)	299.84
8. VII Five Year Plan (1985-86 to 1989-90)	365.50
9. Annual Plan (1990-1991)	82.90
10. Annual Plan (1991-1992)	87-90
Grand Total (1958 to 1992)	1335.05

NMEP

VIII Five Year Plan (1992-93 to 1996-97)

1992-93	- 97.80
1993-94	- 110.00
1994-95	- 110.00
1995-96	- 142.00
1996-97	- 145.00
Sub-Total	Rs. 604. 80

Tentative Proposal (1997-1998 to 2001-02)

Items	Centre Share: Govt. of India	Centre Share: External Assistance	Total	State Share
A. NMEP (Rural)	1280.62	536.43	1817.05	1021.00
B. NMEP (Urban)	93.58	19.40	112.98	10.00
C. Physical facility H.Q.	30.00	68.40	98.40	-
Total for malaria	**1404.20**	**624.23**	**2028.43**	**1031.00**
D. Filaria	63.47	-	63.47	2.00
E. Kala-azar	84.40	-	84.40	-
F. J.E.	5.50	-	5.50	2.50
G. Dengue	4.50	-	4.50	2.50
GRAND TOTAL	**1562.07**	**624.23**	**2186.30**	**1038.00**

Annexure- 7.1

Action Plan for Procurement

Sr. No.	Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
1.	Estimation of requirement of items													This is to be done after the approval of project
2.	Proposal for expenditure sanction from MOH (If required)													If MOH has instructed to procure the products through procurement cell and MSO
3.	Invitation of Tenders													with the approval of Technical
4.	Recommendation of Purchase Committee													Committee under the Chairmanship of Drug
5.	Placement of supply order													Controller of India
6.	Supply of material													
7.	Monitoring of supply													
8.	Payments to the firms													Payments will be made by NMEP.
9.	Monitoring of stock position													
10.	Estimation of requirement of various items													With the help of State Health Authorities.
11.	Estimation of budget involved													

Annexure- 7. 2

Comparative Cost of Insecticidal Spraying in India per Annum during 1995-96 (Per Million Pop.)

Sr. No.	Name of Insecticide, Dosage and No. of Rounds per annum	Total requirement MT	Cost per MT Rs.	Total cost of insecticide per annum Rs. in Lakhs	Operational Cost		Storage & Transport @Rs.2/- per kg. Rs. in Lakhs	Total cost Rs. in Lakhs	Per capita cost in Rs.
					Wages @Rs. 30/- per day per worker Rs. in Lakhs	Protective Garments @Rs.300/- per worker Rs. in Lakhs			
1.	DDT 50% wp 1 gm/m² 2 Rounds	150	55,459	83.19	12..33	-	3.00	98.52	9.85
2.	BHC 50% wp 0.2 gm/m² 3 Rounds	336	19,192	64.49	18.50	-	6.72	89.71	8.97
3.	MALATHION 25% wp 2 gm/m² 3 Rounds	900	35,983	323.85	18.50	0.82	18.00	361.17	36.12
4.	DELTAMETHRIN 2.5% wp 0.02 gm/m² 2 Rounds	60	7,20,000	432.00	12.33	0.82	1.20	446.35	44.64
5.	CYFLUTHRIN 10% wp 0.025 gm/m² 2 Rounds	18.75	23,00,000	431.25	12.33	0.82	0.38	444.78	44.48
6.	LAMBDACYHALOTHRIN 10% wp 0.025 gm/m² 2 Rounds	18.75	22,13,000	414.94	12.33	0.82	0.38	428.47	42.85
7.	LINDANE 6.5% wp 0.2 gm/m² 3 Rounds	336	46,000	154.56	18.50	-	6.72	179.78	17.98

Annexure- 7.3

Comparative Cost of Larvicides per Million Population per Annum Based on 1994-95 Prices

Sr.No.	Name of Larvicide	Cost of Larvicide in Rs.	Requirement of larvicide per hectare per annum	Requirement of Larvicide per one million population per annum	Cost of Larvicide per one million per annum Rs. in Lakhs	Per head cost population Rs.
1.	MLO	4000/KL	10.4 KL	3,295 K. Lit	131.80	13.18
2.	TEMEPHOS	507/LIT	2.6 Lit	824 Lit	4.18	0.42
3.	FENTHION	632/LIT	5.2 Lit	1,648 Lit	10.42	1.04
4.	*Bacillus thuringiensis*	400/KG	130 Kg	41,190 Kg	164.76	16.48
5.	*B.sphaericus*	400/KG	173.3 Kg	54,920 Kg	219.68	21.96

Note: 1. The Larvicides at Sr. No. 4 and 5 are Biocides.

2. It is estimated that on a average 316.85 hectare water surface per one million population is created/formed.

SECTION-5
APPLIED AND OPERATIONAL RESEARCH IN MALARIA

INTRODUCTION

The resurgence of malaria and fulminating epidemics in recent years pose a formidable challenge to the management of programme. The precipitating problem of resistance in vectors to the conventional insecticides and emergence of *P.falciparum* strains resistant to Chloroquine have accentuated the gravity of problem to new dimensions. To overcome the disturbing situation, most effective scientific and technological tools will have to be deployed. The big strides made in diagnostic methods, molecular biology, immunology and chemotherapy have opened up new vistas for development of modern tools. In the light of advances made in science and technology, high priority shall be accorded to applied and operational research in malaria which assumes a high degree of urgency.

The knowledge on different aspects of malaria expanded gradually and underwent many changes from the days of Sir Ronald Ross who made the epoch making discovery of malaria transmission in Secunderabad (Andhra Pradesh) way back in 1897. Fortunately India has been in forefront in the application of relevant research findings in malariology to the national programme. The scientific community will have to compensate the complacency developed in recent years and quickly forge ahead with newer ideas and innovations in the combatment of the disease. Malaria should not be allowed to reoccupy number one position of public health problem as it used to be in the pre-eradication era and this handicap must not recur as an obstacle in the way of overall national developmental activities in different spheres.

Many research institutions in India under the aegis of Indian Council of Medical Research and Department of Science and Technology have been doing many field oriented research studies on malaria.

ORGANISATIONS TO BE INVOLVED IN MALARIA RESEARCH

Some of the premier institutes identified for conducting research in malariology including sero-surveillance and diagnostics tools are listed below:-

1. Malaria Research Centre, Delhi.

2. National Institute of Communicable Diseases, Delhi.

3. National Institute of Virology, Pune.

4. All India Institute of Medical Sciences, New Delhi.

5. National Inst. of Health & Family Welfare, New Delhi.

6. National Institute of Immunology, New Delhi.

7. Centre for Research in Medical Entomology, Madurai.

8. School of Tropical Medical Entomology, Madurai.

9. King Institute of Preventive Medicine, Madras.

10. Institute of Vector Control & Zoonoses, Hosur, (T.N.).

11. Vector Control Research Centre, Pondicherry.

12. Kyasanur Forest Disease Laboratory, Shimoga, (Karnataka).

13. Veterinary Biological Research Institute, Hyderabad.

14. Haffkine Institute, Bombay.

15. School of Tropical Medicine, Calcutta.

16. All India Institute of Hygiene and Public Health, Calcutta.

17. Central Research Institute, Kasauli.

18. Central Drug Research Institute, Lucknow.

19. Medical Colleges at Lucknow, Gorakhpur, Burdwan, Dibrugarh, Panaji, Cuttack, Visakhapatnam, Jaipur, Mangalore, Madras, Pune, Bhopal, Chandigarh, Vellore, Pondicherry, etc.

20. The Universities in endemic areas which are involved in applied research in malaria.

Besides the above institutes, other organisations involved in applied research will have to be identified in different endemic parts and each institute could carry out sero-surveillance in two to three districts each to map out the profile of important communicable diseases including malaria, filaria, Japanese Encephalitis, Kala-azar, Dengue, etc. This will help in instituting appropriate integrated disease vector control to achieve the national goals of good health. Some of the areas of research indicated below have already been identified by Dte. of NMEP and MRC under different projects.

AREAS OF RESEARCH IN MALARIOLOGY

1. Field oriented operational research on malaria control.

2. Identification of malaria paradigms and sub-paradigms and the changing pattern in the eco-epidemiological situation.

3. Bio-environmental control methods as integrated part of vector control approach through community involvement.

4. Vector bionomics, species complexes, insecticidal resistance and alternative control methods.

5. Chemotherapy of malaria and drug resistance.

6. Sero-surveillance and diagnostic tools.

7. In-vitro cultivation of malaria parasites and animal models.

8. Immunology of malaria including search for malaria vaccines.

1. Field Oriented Operational Research on Malaria Control

Field oriented operational research assumes considerable importance as the efforts in this direction are likely to yield rich dividends in achieving cost-effective control strategy. Investigations on epidemiological and entomological aspects of malaria in different ecosystems will throw light in adopting appropriate control measures. Dynamics of malaria transmission in respect of different species in different endemic belts are to be studied to improve the operational efficiency of control measures. Studies are required to devise assessment methods in respect of various components of malaria containment programme including malariometric indices to be adopted in the programme. Mathematical models to measure the magnitude of transmission are to be developed using currently available data. Optimum control methods using antilarval measures in rural areas especially in semi-arid region are to be studied to interrupt the transmission. The relative advantages of emulsion formulations over wettable formulations for improved public acceptance including urban and peri-urban population with new generation insecticides require to be probed.

The cost-effectiveness of pyrethrum space sprays in triple resistant areas is to be studied. Pilot studies on the use of impregnated bednets as a sustainable method through community participation in different areas including remote inaccessible areas need to be taken up urgently. Studies will have to be carried out to forecast epidemics in high prone areas to undertake preventive measures.

2. Identification of Paradigms and Subparadigms and the Changing Pattern in the Eco-Epidemiological Situation

The efforts for control of malaria will fail unless epidemiological and operational stratification of different terrains is carried out taking into consideration, the changing patterns of ecosystem, human behaviour, parasite characteristics, malariogenic potential of the area, etc. The ecosystem is constantly subjected to drastic changes due to influences of developmental

activities. Deforestation, changing cropping patterns, urbanisation, construction of river valley projects, irrigation, etc. bring substantial changes in the eco-epidemiological situations. The natural disasters like earthquake, floods, drought, etc. temporarily may affect malaria endemicity and immediate measures are to be instituted to prevent outbreaks. The peripheral workers at district and PHC levels will have to identify different malaria paradigms and subparadigms from time to time due to fast changing patterns of ecosystem to implement appropriate strategy.

3. Bio-environmental Control Measures as Integral part of Vector Control Approach through Community Involvement

The control of disease vectors by an integrated approach which includes improvement of environment, source reduction, biological methods especially using larvivorous fish in a coordinated pattern has been successfully demonstrated by the Malaria Research Centre and such projects have to be extended to other areas through non-governmental organisations involving active participation of community as a sustainable strategy.

4. Vector Bionomics, Species Complexes, Insecticidal Resistance and Alternative Control Methods

It is well known that the vector behaviour in one region is not applicable to other regions and the control measures need to be developed for a particular locality. It is essential to select as many representative areas as possible to carry out intense investigations through 72 Entomological Zones in the country and other research institutes. The specific studies include composition of anopheline fauna, seasonal and relative densities, incrimination of vectors, breeding, feeding and resting habits, man mosquito contact, flight & dispersal range, susceptibility status, etc.

The studies conducted by MRC revealed the presence of species complexes and sibling species and their role in malaria transmission. The principal rural vector, *An.culicifacies* is a complex of four sibling species and sibling species 'B' is not a vector in India except in Rameswaram Island warranting further probe in the species complex. *An.philippinensis* is a known vector in deltaic Bengal but not in Assam. In many areas the species is identified as *An.nivipes*. Similarly *An.leucosphyrus* complex was represented by *An. balabacensis* and *An.elegans*. The former is now identified as *An.dirus* in India. *An.fluviatilis* and *An.maculatus* are also identified as species complexes. Extensive studies are to be undertaken to map the species complexes of different *Anopheles* especially malaria vectors in the entire country.

Insecticidal resistance, its biochemistry and genetic aspects are to be studied on priority basis.

5. Chemotherapy of Malaria and Drug Resistance

Premier institutes in India like CDRI, Lucknow, NICD, Delhi, MRC, Delhi, Haffkine Institute, Bombay and School of Tropical Medicine, Calcutta should take up/intensify screening programme for new antimalarial drugs which are causal prophylactic as well as curative and effective gametocytocidal drugs active against resistant strains. Long acting repository drugs will be more advantageous in developing countries like India.

Mapping and monitoring of *P.falciparum* resistant areas will have to be expedited by establishing more monitoring teams and training of personnel in the endemic States to conduct extensive studies to arrest the spread of resistant strain and liquidation of resistant foci. *In-vitro* studies are also to be intensified in selected areas.

Pharmacological studies on drug absorption, and metabolism in respect of disabilities like severe anaemia, malnutrition, malabsorption, liver disorders, hypoproteinaemia, etc. are to be conducted extensively. Biochemical studies and nutritional aspects of malaria parasites will have to be taken up by the identified institutions on priority.

6. Sero-Surveillance and Diagnostic Tools

As already indicated, the premier research institutions and medical colleges could adopt 2-3 districts each to undertake sero-surveillance of

statistically valid sample size so that the results could be extrapolated to the entire Subcentre or PHC or classification of the district on the basis of endemicity.

Serological techniques commonly used in the detection of malaria antibodies mainly consist of **i.** immuno-precipitation, **ii.** immuno-flourescense (IFAT), **iii.** indirect haemagglutination (IHA), **iv.** enzyme linked immuno-sorbent assay (ELISA), **v.** radio-immuno-assay and **vi.** merozoite inhibition in culture. Serodiagnosis was found to be of practical value since 1962 when IFAT was introduced. Collection of capillary blood on filter paper for serological test was successfully used in the field. Molecular biological detection tests incorporating DNA and RNA probes have opened up several new techniques for diagnosis of malaria in man. Simple dipstick method capable of detecting all the four human malaria infections with high degree of sensitivity and specificity, if cheaply produced within the country would revolutionise the entire spectrum of diagnostic technology.

7. *In-vitro* Cultivation of Malaria Parasites and Animal Models

In-vitro cultivation of *P.falciparum* is being successfully employed for screening of drugs for antimalarial activity and to assess the resistance status of *P.falciparum* to Chloroquine and other antimalarials. Though good progress has been made for *in-vitro* cultivation of *P.vivax*, the techniques need to be further refined for mass scale application in future.

Studies on cultivation of sporogonic and exo-erythrocytic stages in tissue culture are to be intensified. If exo-erythrocytic stages of animal malaria are cross-immunogenic against human malaria, it may help in the production of malaria vaccine. It is necessary to study the species specificity of the immunity produced by tissue stages of malaria parasite.

Studies for animal models for human malaria parasites should be probed. Animal models like monkeys such as *Macacca fasicularis, Aotus trivarigatus* and similar type of monkeys indigenously available should be explored for development of animal models for human malaria species.

8. Immunology of Malaria Including Search For Malaria Vaccines

Studies on immunological aspects are important for ultimate goal of developing an effective vaccine against malaria infection. Investigations on immuno-pathology affecting various organs are necessary for formulating appropriate treatment. Presence of immune sera was found to enhance antibodies. There is an urgent need to investigate immune response to malaria infection and role of humoral and cell-mediated immunity in malaria. Different stages of irradiated malaria parasites have been tried to immunise vertebrate hosts against malaria infection. Research studies have to be taken up on immuno-suppressive effect of malaria parasite. Investigations are to be conducted on red cell polymorphism, haemoglobinopathies, specific or non-specific immunity either acquired or innate to understand host-parasite relationship. The high risk population groups with G6PD deficiency are to be identified in view of severe side effects of 8-aminoquinoline drugs.

The advent of monoclonal antibodies and recombinant DNA technology has facilitated the prospects of developing vaccines against all the stages of malaria parasite. The progress made by some premier institutes towards development of malaria vaccine is given below:-

i. CDC Atlanta (USA)

Multi-valent multi-stage, *Plasmodium falciparum* subunit vaccines have been developed which allow incorporation of different epitope sequence in one construct. Multiple Antigen Constructs (MACs) targeted epitopes on different stage specific malarial antigens in rodents model. It has been demonstrated that mice immunised with *P.berghei* and *P.yeolli* CS MACs vaccine induce sterile immunity. In another study, it was found that MACs that contained the CS repeat epitopes of *P.falciparum* and *P.vivax* like human malaria parasite induced long lasting high titer anti-bodies in mice against both epitopes. It was found that select epitopes of malaria antigens

could be utilised in complete neutralisation of the infectivity of the human malaria parasite, thereby moving one step closer to an efficacious multistage malaria vaccine.

ii. CRC for Vaccine Technology, Australia

Proteins exposed on the merozoite surface are considered potential vaccine components because antibodies directed against such molecules can block the invasion of erythrocytes by merozoites. Proteins identified on *P.falciparum* merozoite surface include GPI - anchored proteins (MSP-1, MSP-2 and MSP-4), type-I integral membrane proteins (AMA-1, and EBA-175) and proteins lacking the structural features of integral membrane proteins (MSP-3). The two leading asexual blood stage vaccine candidates are MSP-1 and AMA-1, both of which have been extensively studied using mouse models.

iii. International Centre for Genetic Engineering & Biotechnology, New Delhi

Erythrocyte invasion, antigen variation and cyto-adherence are three important pathogenic mechanisms in malaria. The parasite molecules that mediate these mecahnisms belong to a super family that is referred to as the DBL super family. The super family has two branches, one branch consists of the erythrocytic binding protein family which includes the Duffy binding proteins of *Plasmodium vivax* and *P.knowlesi* and the siatic acid binding protein, also known as EBA-175, of *P.falciparum*. The other branch consists of the var gene family which encodes the variant surface antigens of *P.falciparum*.

iv. Affymax Research Institute, Santa Clora, USA

The capacity of the parasite to express variate antigens on the surface of PEC (Parasitised erythrocytes) also contributes to the special virulence of *P.falciparum*. Pf EMP1, a malaria protein expressed on the surface of PE is associated with both antigenic variation and PE adherence. Thus, Pf EMP1 plays a central role in the biology and pathology of *P.falciparum*. It has been demonstrated that Pf EMP1 from PE binds directly to the three major host receptors, CP36, thrombospondin and ICAM1. The CD36 binding domain is a prime target for a malaria vaccine.

APPLIED AND OPERATIONAL RESEARCH PROJECTS

The Research Scientists of the NMEP and MRC have jointly identified areas of applied and operational research that are important to the success of the malaria control action plan. Studies requiring priority attention are given hereunder:-

A. Applied Research

1: Insecticide resistance: Studies on resistance in *An.culicifacies* to synthetic pyrethroids would be important in view of the change over from Organochlorine and Organophosphorus compounds to Synthetic pyrethroid compounds. *An.culicifacies* has already become resistant to DDT, HCH and Malathion, but field populations are fully susceptible to synthetic pyrethroids (SP). In the integrated malaria control strategy, SP compounds would be used in large quantities for some time as residual spray, and largely for the impregnation of bednets. Exposure of the vector populations to SP compounds may create problems in control either by inducing resistance or exophilic behaviour. Applied field research is therefore indicated on the: a). proportion of deterrent and killing action of SP compounds used in dipping of bednets; b). mechanism of resistance to SP compounds and cross- resistance within SP compounds in species A and species C of *An.culicifacies*; c). exophlic vector behaviour and impact of bednets in accelerating selection for exophilic vector behaviour; and d). counter measures to overcome for exophilic vector behaviour to SP compounds. Since bednets would be used in areas under the influence of *An.stephensi, An. minimus, An.fluviatilis* and *An.dirus,* similar studies may be required against these vectors as well.

2: Drug resistance : There are reports of resistance in *P.vivax* to Chloroquine from Indonesia, Papua New Guinea, and a few more. It is possible that *P.vivax* strains resistant to Chloroquine may also be evolving in India. It is therefore important to detect early and take remedial measures to eradicate the build up of

such foci. Monitoring of *P.vivax* sensitivity to Chloroquine is therefore indicated all over the country.

3: Large quantities of antimalarial drugs are used in the treatment of malaria, but reports on the side effects/serious reactions are very few and not well documented. Obviously such drug reactions are being missed. An epidemiological investigation is indicated on the drug reaction particularly in high risk groups and those with genetic abnormalities.

4: Malaria is entering into new areas due to environmental changes. A study on the impact of ecological changes, global warming and meteorological factors is important in the context of rapidly deteriorating epidemiologiocal situation of malaria.

5: The epidemic in 1994 Rajasthan has thrown up many challenges in regard to vector control and management of disease. Arid zone ecology of malaria transmission is poorly understood particularly under the abnormal conditions of rainfall and irrigation. *An.stephensi* was a well known vector in Rajasthan but now there are vast stretches of land water logged due to Indira Gandhi Canal where *An.culicifacies* has a strong foothold. Additionally *An.fluviatilis* has been reported in some areas. Precise role of these vectors in malaria transmission has to be investigated. It is important to investigate the vector biology of the immatures and adults to develop new control tools. Studies are also required on the status of resistance in *P.falciparum*, dynamics of transmission, methods to prevent deaths in difficult terrain areas and develop a package suitable for the Panchayat to prevent vector breeding and take remedial measures as may be required to interfere with the local transmission.

6: Long term research support is indicated on the diagnostics, new drugs, new insecticides, immunological studies, new approaches in malaria control e.g., remote sensing, geographical information system, micro-epidemiology using molecular approaches, etc.

B. Operational Research

1: The Problem of Chloroquine resistance in *P.falciparum* is increasing. Urgent need is felt in the programme to investigate the transmission dynamics of drug resistance in *P.falciparum* malaria; diffusion mechanism and speed with which resistant strains are moving inwards from the international borders and methods of control. Because of the implications of drug resistance in the treatment of malaria, it is felt that a suitable mechanism may be developed for rapid assessment of the status of the drug resistance in *P.falciparum*. For this purpose feasibility studies may be undertaken on 3 and 7 day *in-vivo* test at the Primary Health Centres.

2: Early warning system applicable and sensitive for the existing Primary Health Care System should be developed. This would require collection of sensitive parameters, computerisation of data, and software to raise alarm before the onset of epidemics. This will abort outbreaks, prevent diffusion of disease, reduce morbidity and mortality and save resources required in fighting the epidemic situations.

3: Agriculture, industry, construction works, etc. attract labour and largely the pattern of population migration is well established. Droughts, floods and disturbed political situation also cause large scale population movements. There are no epidemiological investigations on the impact of migration in the dissemination of parasite strains, particularly the incidence of serious malaria episodes, mortality due to malaria in the indigenous population and impact on the build up of resistance in *P.falciparum* to antimalarial drugs. Results of this study would help in the development of strategy to prevent the dissemination of the parasites.

4: There are very few studies in the country on sociological factors affecting the success of malaria control programme. These studies have become all the more important in view of the change-over to the integrated malaria control strategy envisaging the active participation of communities and

involvement of Panchayats in the prevention of malaria morbidity and mortality and in the sanitation programme. In this context it is important to know the felt needs of the communities, how the communities perceive malaria, vector breeding sites and how these are being created, behavioural studies related to the use of drugs and their faith in various systems of medicine, etc. In regard to interventions, particularly success in insecticide impregnated bednets will depend on the proper use and care of bednets and therefore studies are indicated on the human factors that will interfere with the proper bednet usage as a method of malaria control in each ethnic group.

5: Cost effectiveness of malaria control requires continuous monitoring of the impact of interventions and a cost analysis directed to bring out the best combination of methods applicable under a given epidemiological situation. Therefore, practical methods of cost analysis under a decentralised malaria control programme would have to be developed and field tested before these are incorporated into the training modules on the implementation of integrated malaria control strategy.

6: The components of information, education and communication (IEC) are weak in the programme. IEC component in the delivery of an effective malaria control programme based on community approach would require the knowledge of local transmission, problems in malaria control, vector biology of the target species, factors of human ecology, sociological factors and control tools. This would help in designing targeted IEC material in local languages keeping in view the perceptions, expectations and responsibilities of the communities in malaria control. This would be in addition to the general IEC at the national and State level. Research is indicated on the development of suitable IEC material at the lower levels of health delivery system.

7: Health impact assessment (HIA) in the environment impact assessment (EIA) is being introduced as an important component of the malaria control strategy. In many areas of growing economy projects in the field of agriculture, industry, human settlements, etc have created enormous mosquito breeding potential. Research is indicated on the magnitude of this problem, mitigating measures which are cost effective and sustainable and future planning to prevent malariogenic conditions.

8: Management information system is being developed and strengthened. Research is indicated on the integration of malaria activities, software development, data collection and analysis, information dissemination for rapid action, and programme planning for the smooth functioning of the malaria control activities at the periphery.

SELECTED REFERENCES

1. Bradley. A.K., Greenwood. B.M., Greenwood, A.M., Marsh. K., Byass, P., Tullock. S. and Hayes, R (1986): Bednets (mosquito nets) and morbidity from malaria. *Lancet,* ii: 204.

2. Dte. of NMEP (1995): Operational Manual on Malaria Action Programme. Govt. of India, Publication, Dte. of NMEP, Delhi-110054. P.

3. ICMR(1977): Research in Malaria (An outline) published by the Indian Council for Medical Research, Ansarinagar, New Delhi. P.1-35.

4. Rozendall, J.A. (1989): Impregnated Mosquito Nets and Curtains for Self-protection and Vector Control. *Trop. Dis.Bull.,* **86**:R1.

5. World Health Organisation (1982): Manual on Environmental Management for Mosquito. WHO Offset Publication No. **66**.

6. World Health Organisation (1983): Integrated Vector Control. *Tech. Rept.Ser.No.* **688**.

8

ENGINEERING METHODS FOR MALARIA CONTROL

SECTION-1
SITE SELECTION FOR HUMAN SETTLEMENTS - CITIES AND TOWNSHIPS

INTRODUCTION

While discussing the malaria paradigms and their transmission dynamics in Chapter - 5, it has been brought out that the changes in local malaria endemicity are always due to man-made environmental changes. The developmental activities in an area taken up by the community normally result in permanent changes in the biotope of the locality. Most of the developmental schemes involve engineering activities like construction of roads, rail tracks, canals, dams, urban housing and setting up of industrial complexes. These activities result in change in natural drainage gradients in the area, thereby influencing the surface water flow during rainy season, sometimes resulting in water logging, rise in sub-soil water and general change in mosquito breeding habitats. Malaria control through minor engineering and inexpensive methods suggested by Sir Ronald Ross was demonstrated in India. It is widely recognized that poor engineering methods increase the mosquitogenic potential of the area. **Malcolm Watson said 'Engineering, which leaves a trail of malaria is bad engineering'. It is also stated that the type of economy which gives rise to man made malaria and agriculture decline is a false saving.** The expenditure which is incurred at a later date to remedy the harm caused by developmental projects is usually much greater than initial inputs needed to prevent the mosquitogenic conditions.

It has also been observed that problems connected with water supply and its storage and drainage in urban areas result in increased mosquitogenic potential causing high incidence of malaria in urban areas. A wrong decision by engineers in alignment of roads, railways and even canal system results in obstruction of natural drainage of the area.

In the beginning of this century, a great emphasis was laid on engineering methods for control of malaria. Malaria control in Sarda canal project in Uttar Pradesh adjoining Nepal border and site selection for construction of New Capital in Delhi Region in 1930 stand out as the best classical examples in the containment/prevention of malaria. The decision was finally arrived at after considering the mosquitogenic potential of the surrounding areas and other sites proposed for construction of capital. The capital was shifted from old Delhi from the banks of Yamuna river to Delhi ridge area because this area provided most suitable drainage gradient and it was considered to be more healthy.

Similarly it has been observed that most of the urban constructions, development of housing colonies, construction of dams and canals, if not located on proper site results in enhanced malariogenic potential in the area. **During eradication era using insecticides for control of malaria, this aspect was lost sight of. Failure to**

control malaria by residual insecticide spray on account of operational and technical problems and realising the fact that malaria eradication is not feasible in the near future, the global strategy (1992) of malaria control laid emphasis on selective vector control measures recommended for priority areas on account of developing resistance to insecticides in local vectors. They have also advocated use of alternative methods for prevention of malaria. The engineering methods for control of malaria will, therefore, play a major role in malaria control operations.

Keeping this in view, it is felt that the malariologists and engineers should be made aware of appropriate engineering techniques for preventing increase in malariogenic potential in developmental projects. In this chapter, endeavours have been made to describe appropriate engineering methods to be taken up in developmental projects for this purpose.

FACTORS GOVERNING LOCATION AND GROWTH OF A TOWNSHIP

A very few townships in the country have been developed as per master plan, while the majority of them have grown on their own. Smaller townships grow close to big urban and industrial centres as satellites. These agglomerations come up more as prerequisites to principal town, since they thrive on the resources of the principal town and burden them with gross civic problems. Almost all the big towns and cities in the country have become the victims of this phenomenon.

Malaria, a potential hazard to human community, has hardly been a consideration in the selection of the site of a township.

The unplanned growth of the principal or the satellite township often creates mosquitogenic situations and consequently exposes the population to mosquito borne diseases including malaria. It is appropriate to mention here that during 1930s when British rulers planned to build the capital city of India at Delhi, outside the walled city North West of Khyber Pass, a Public health expert, Major Hodgkins, rejected this site only on consideration of malariogenic potential of the area and suggested the location of New Delhi and Cantonment at the present site (Fig- 8.1). As a result New Delhi was developed on both sides of ridge on a well drained land. Later on Director, Malaria Institute of India headed a development committee which approved expansion and further construction in Delhi. However, with the implementation of Delhi Corporation Act, the above system was abandoned and today the new colonies in Delhi are coming up in areas which have a high malariogenic potential through bad planning without taking into account the health hazards. History bears witness to many towns being wiped out due to malaria; most outstanding example is of Ganjam township and surrounding villages in coastal Orissa in early 20th century. In many townships conditions favourable to mosquitoes were created due to developmental activities without considering its likely adverse impact on mosquitogenic potential or human health.

Malaria Vectors and Their Breeding

Amongst vectors, only one or two are responsible for the transmission of malaria in urban areas - *An.stephensi* in compactly built-up area and *An.culicifacies* in peri-urban areas.

Urban Construction Obstructing the Natural Drainage of the Area

The construction programme interferes with natural drainage. The low lying areas especially tanks and ponds were the recipients of storm water run-off. They are no longer available to receive the run-off. The storm water therefore collects at multiple points forming small water pools. These offer a much longer shoreline than that was available prior to the construction programme. Mosquito population in the area instead of decreasing is therefore likely to increase.

Lack of Proper Drainage Creating Mosquitogenic Problem

In most instances the drainage projects lag far behind construction programme. In many instances mostly due to lack of funds, storm water drainage installation has not been implemented even after 50 years, since the beginning of township. Conditions created by such

unplanned development of town exposes people living in these urban areas to serious hazards of mosquito borne diseases.

Some Considerations for Site Selection

A site free from undulations and with ground gently sloping down to a running stream facilitates drainage of run-off water with low investments. In certain areas it may be possible to divide the town into several zones based on ground contours. Each zone becomes a drainage basin independent of the others. The towns which grow along the slope of hills are favourably placed while those that are situated at the foothills are difficult to tackle due to absence of suitable natural gradient where the water stagnates.

Treatment of Pre-existing Water Bodies at the Selection Site

As far as possible it is desired that the site for the township is free of water collections. Wherever possible small water collections may be drained or the breeding places are filled. Formation of a single large tank in place of a number of small pools will very much reduce the shoreline and thereby reduce mosquito breeding sites by using larvivorous fishes like Gambusia and Guppy.

Advantage of Locating Township away from Big Water Bodies

It is advisable to locate the township away, at least beyond the flight range of the vector mosquito (say 3 km) and it should preferably be on the windward side of the reservoir so that in the air current, the mosquitoes will be carried away from the residential areas.

PREVENTIVE MEASURES WHICH CAN BE IMPLEMENTED IN RUNNING WATER SOURCES NEAR A TOWNSHIP

Likewise in the flat terrain a meandering river presents a situation favourable for mosquito breeding. With the monsoon receding, the river gradually shrinks leaving behind a number of water collections on its exposed sand beds. All these collections are potential breeding grounds for mosquitoes. The flow in the river itself is sluggish which permits breeding of mosquitoes. Siting a township beyond the flight range of mosquitoes from these river beds will prevent invasion of the township by the mosquitoes. River training is very useful in maintaining a predetermined alignment for the flow of the river during the dry season accompanied by proper canalising the flow to maintain a self cleaning velocity (0.6 m/per second).

In case of slow moving streams it may be possible to control breeding of mosquitoes by flushing the streams at least once a week.

Preventive Measures in Swampy and Other Areas

Township should not be sited close to swamps so as to be away from the flight range of mosquitoes. Many factors other than the consideration of malaria situation at a future date determine the choice of the site for a township or for expansion of an existing township. Since larvicidal measures are repetitive in nature and expensive, it is desirable that the water is drained out. The most effective way of draining a swamp is to provide sub-surface drainage. In certain hydrogeological formations it may be possible to adopt vertical drainage.

Precautions for Coastal Townships

Coastal areas often present favourable situation for the mosquitoes to breed. Ground slope is usually low. The tides bring water and inundate low lying areas which remain water bound even after the tide recedes. Mosquitoes breed in these retained waters which are fed by tides, rain and waste water from the community. Such sites should be avoided as far as possible for townships. If siting of townships in such areas becomes inevitable, construction of dikes and embankments at suitable places will prevent inundation of the hinter land.

EFFECT OF CONSTRUCTION OF ROADS, RAILS, CANALS AND HOUSING COMPLEX ON NATURAL DRAINAGE

Roadways and railways almost invariably interfere with natural drainage. Unless suitable drainage system is incorporated along with these

projects, water may stagnate and form pools alongside the communication line and breed mosquitoes. Drainage is the best solution to the problem and should be integrated with the roadway and railway projects.

Irrigation canals placed on land offer obstruction to natural drainage and also cause seepages. Drainage with culverts placed at suitable points is the best approach to combat the situation. A new township should not be planned within the area of 3 km of irrigation canals. Likewise the alignments of canals should be so planned that it is at least 3 km away from existing towns and cities.

Building construction programme upsets the terrain of the place and may create conditions favourable for mosquito breeding. Drainage seems to be the most effective measure to avoid mosquitogenic conditions. The knowledge of the bionomics of the vector species in the region should help in the choice of the site and also adoption of suitable control measures. The choice is guided by the presence of minimum unfavourable conditions. If one is required to select a site amongst a few, elevated and well drained sites are most desirable.

It is, therefore, suggested that public health specialists, malariologists and entomologists should form a part of the team which decides site selection of a new township or expansion of the existing sites. Their association with the team of experts in water resource and industrial complex development is very essential as these projects not only affect the workers and residents in the project area but also the rural communities located and likely to be created for resettlement of displaced persons in the vicinity of such projects.

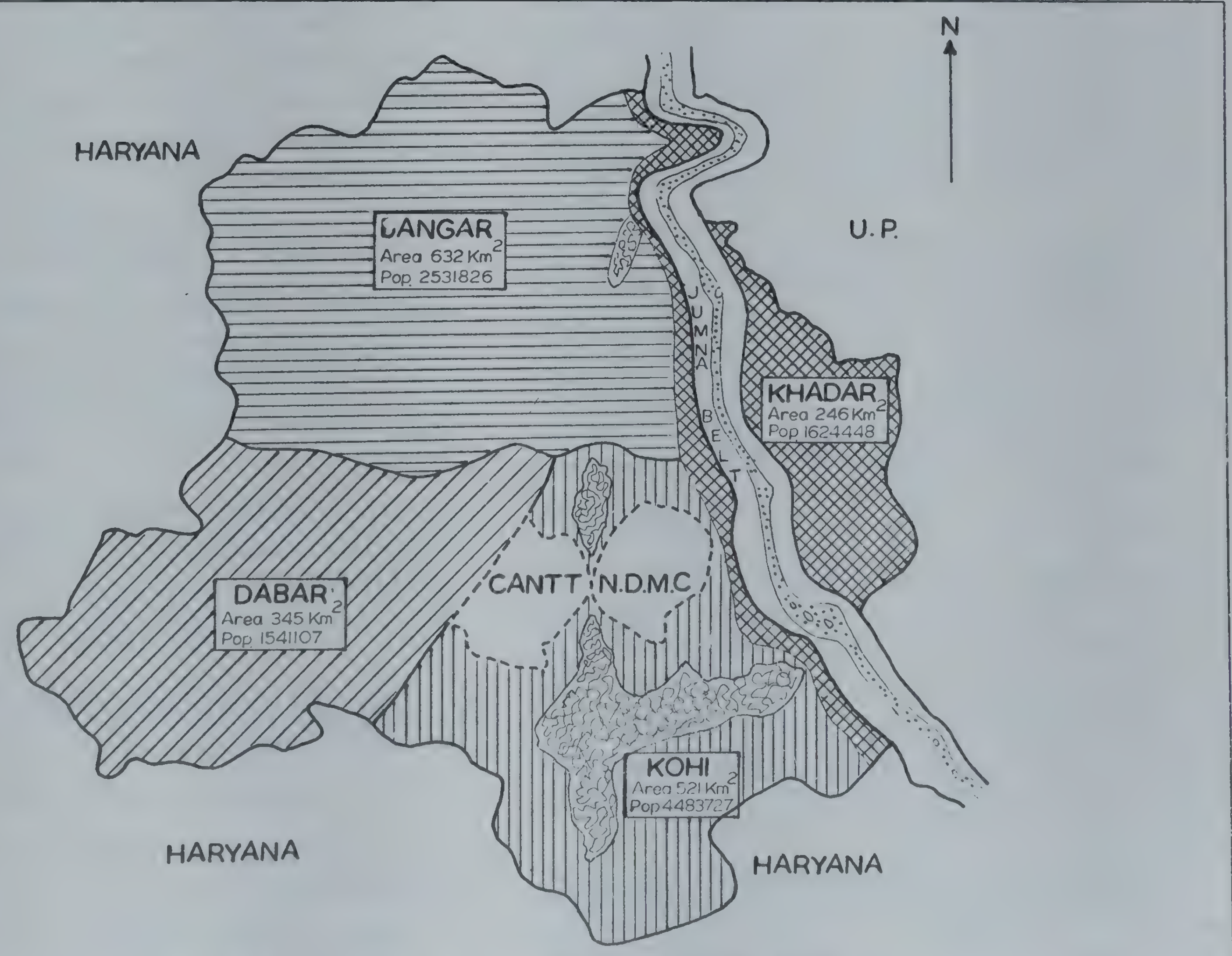


Fig. 8.1 : Delhi Physiographic Regions

SECTION-2
MOSQUITOGENIC PROBLEMS CONNECTED WITH WATER SUPPLY SYSTEM

INTRODUCTION

Many water collections could be the result of natural phenomenon like rainfall and a sizable proportion of water collections could be attributed to the various human activities. For example, digging of burrow pits for railways or road constructions, digging of a temporary well, making brick-soaking sumps, etc. may lead to formation of permanent breeding grounds for mosquitoes. For this reason often the problem of mosquito *vis-a-vis* malaria is reckoned as a man-made one, particularly in urban sector. In this section the relationship of problems of mosquitoes, particularly malaria, with urban water supply will be dealt.

Considering the water supply and the mosquito problems, the first set of observations would be on the mode of supply, storage and service reservoirs, transportation to consumers and water use and storage by the consumers. The second set will be the disposal of waste water.

The attention of the engineers incharge of water supply is usually focussed to see that the water is adequate, safe and it reaches the consumer through a hydraulically sound distribution system. They probably do not consider whether the reservoirs are inaccessible to mosquitoes or stagnant pools of water from leaky valves and faulty joints remain patent for more than 7 days or are drained within 7 days or whether the waste water from a public stand post or a hand-pump is leading to a small cess pool. Similarly, the consumer is interested only in getting adequate and safe water for his daily use. The Sanitary Engineer or the consumer feels concerned about the safe removal of waste water and does not probably think about the mosquito breeding in the gully pits or septic tanks, etc.

Therefore, it is the lack of knowledge about mosquito breeding and realisation of the seriousness of the problem which leads to human activities resulting in mosquitogenic conditions. A prudent water supply system management will give due consideration to the mosquito problem, with appropriate preventive measures by the water and sanitary authorities and above all people's awareness resulting in individual activity.

GENERAL BASIC PRINCIPLES

It is now possible to identify the situations in various stages of water supply system from where the problem of malaria would emanate. This would enable one to identify the methods of control which would be most effective.

The rapid urbanisation in the developing countries allow dissemination of malaria from town to the peri-urban and rural areas because of frequent movement of population between rural and urban areas. Sometimes due to the fast development of urban areas the peri-urban adjoining lands that had so far been purely rural introduce *An.culicifacies* as the concurrent vector at the fringe areas.

It has now been accepted that an integrated vector control programme is the most appropriate to combat mosquito/malariogenic problems. The WHO Expert Committee on vector biology and control through the Technical Report Series No. 688 suggested the following as the components of integrated vector control schemes:

1. Habitat management and source reduction i.e. draining water source and getting rid off artificial breeding sites.

2. The use of biological control agents.

3. The use of insecticides both as larvicides and adulticides.

4. Personal protection ; and

5. Training and education in vector biology and control.

The environmental management comprises of:-

i. Environmental modification

ii. Environmental manipulation ; and

iii. Habitat management

Modification or manipulation of human habitat or behaviour: The WHO has defined through their Expert Committee Technical Report series No. 649, 1980 as follows:-

Environmental management of vector control: The planning, organisation, carrying out and monitoring of activities for the modification and/ or manipulation of environmental factors or their interaction with man with a view to preventing or minimising vector propagation and reducing man - vector pathogen contact.

Environmental Modification: A form of environmental management consisting in any physical transformation that is permanent or long lasting of land, water and vegetation aimed at preventing, eliminating or reducing the habitat of vector without causing unduly adverse effect on the quality of the human environment.

'Environmental modification includes drainage, filling, land levelling and transformation of impoundments/margins. Although these measures are usually of a permanent nature, proper operation and adequate maintenance are essential for their effective functioning.'

'Environmental manipulation: A form of environmental management consisting of any planned recurrent activity aimed at producing temporary conditions unfavourable to the breeding of vector(s) in their habitats'.

'Water salinity changes, stream flushing regulation of water levels in reservoirs, vegetation removal, shading and exposure to sunlight are examples of environmental manipulation activities.'

Modification or manipulation of human habitation or behaviour. A form of environmental management that reduces man-vector-pathogen contact.

Examples of this kind of approach include siting of settlements away from vector sources, mosquito proofing of houses, personal protection and hygiene measures against vectors, and provision of such installations as mechanical barriers between man & vector and facilities for water supply etc. to prevent or discourage human contact with infested water.

VARIOUS STAGES OF WATER SUPPLY SYSTEM - PROBLEMS OF MOSQUITO/ MALARIA AND THEIR SOLUTIONS

Surface Water Sources

Most of the surface water sources are either from rivers/canals or lakes/reservoirs. In general these sources are located away from the town and in peri-urban or rural areas. Therefore, the vector will not be typical urban vector like *An.stephensi* - but on the other hand may comprise of a variety of vector species. These vectors may not cause urban malaria as such, but would form suitable breeding ground for mosquito vector(s) thereby spreading the vector borne diseases in the nearby locality.

Rivers, Streams and Canals

Usually the natural rivers and canals have flowing water and as such except for the portions where the speed of the flowing water is more than 0.6 m/sec the chance of vector breeding would be remote. However, stream water breeders like *An.fluviatilis* may still breed in streams. Sluicing and flushing would be the solution for such problems. Flushing need not be automatic but experience has favoured the self - initiating and self terminating siphon system (Fig-8.2) instead of hand operated gates.

CANALS

The following measures are suggested for preventing mosquito breeding:-

a. Lining of the canal.

b. Good alignment of the canals and avoidance of sharp bends/curves.

c. Effective canal maintenance to ensure that the canals are in good shape and generally free from vegetation and silting at all times.

d. Canal flushing.

Canal Lining

The benefits resulting from canal lining include:-

i. Saving of water loss through seepage or percolation.

ii. Protection against deformation and breakage of the canal banks.

iii. The prevention of canal scour, silt deposition and weed growth reduces the need for frequent and expensive maintenance.

Paved or Hard Surface

Cement concrete, asphalt concrete, stones or bricks, plastic/rubber sheeting prevent seepages. This paved/hard lining is most durable and resistant to mechanical impact. In addition to controlling the seepage most efficiently, it permits velocities conducive to minimum sedimentation without scoring, and provides maximum obstruction to weed growth. A typical section of canal lining and types of membranes are shown in Fig: 8.3 and 8.4 respectively.

Curves in Canals

Canal with bad alignment rapidly deteriorates through erosion and silting. Canals should, therefore, have long straight reaches and large radius curves as far as possible.

IMPOUNDING RESERVOIRS AND LAKES

The water level variations in the reservoir can be quite wide, up to 3 m or more during a normal year and may be considerably more during droughts. Since the water quantity and quality are of prime importance, the peri-impoundment reservoir preparation is mandatory in the tropics. Algae and aquatic blooms are most troublesome and may encourage mosquito breeding.

Mosquito Problems in Impoundments

It has been observed that in the absence of floating mats of vegetation, mosquitoes do not breed in deep waters far from the reservoir margins. Nor there is any significant mosquito breeding along the steep main shoreline exposed to wave wash. The protected hollows and indentations of the shoreline are areas subject to mosquito problem. The water in such places is usually shallow and filled with aquatic vegetation and floating materials where mosquito larvae find food, necessary protection from currents, wave action, wind, and cover from natural predators.

Strategies for Mosquito Control

a. Proper preparation of the reservoir site, particularly clearing of trees and other vegetation will ensure a smooth water surface at all elevations between high and low operating water levels.

b. The necessary provisions for fluctuating the water level whenever needed. Water level fluctuation is an effective environmental manipulation measure.

c. Suitable marginal drainage to avoid the formation of isolated pools along the reservoir margins when the water level has fluctuated.

d. Permanent works, wherever economically feasible to eliminate vast shallow areas on the margin of reservoir close to high population areas.

e. An effective programme for shoreline and drainage maintenance, vegetation growth control and drift removal after the reservoir has been filled.

Some of the strategies above can be fulfilled through environmental modification measures whereas some through manipulation measures.

Environmental Modification Measures

These measures are mostly directed to the preparation of reservoir sites and shoreline shortening and improvement.

Reservoir Site Clearing

The basin must be cleared of trees, bush, fence, bridges, houses, sheds, etc. which otherwise would disintegrate and decay, and perhaps float, drift to the shore and accumulate at heads of bights and indentation where floats encourage aquatic plant growth and mosquito production. Permanently and completely submerged trees in deeper regions do not pose any mosquito problem.

The shoreline subject to erosion should be cleared up to the extent to which the wave action

is apprehended to effect the shoreline.

Drainage of Reservoir Margin

Marginal drainage must be provided in the zone between the maximum and minimum water levels of the reservoir. Small water collections which can dry up in a few days do not need marginal drainage. Areas that remain in a permanent bogy condition due to existence of sub-surface springs also need drainage. The drainage details are dealt within the section on water disposal.

Deepening and Filling

a. Filling the marginal problem zones to a level above the maximum water level.

b. Deepening the problem zone to a depth below the lower limit of marginal growth invasion or a combination of both (a) and (b). The most economical method would be the combination since excavated earth can be utilised for filling.

Diking and Dewatering

Where deepening/filling would involve major earth-moving operations, it may be necessary to build dikes or levees to isolate large shallow bays for reclamation by dewatering. Such areas, if they remain inundated, could favour large scale mosquito breeding which would be extremely difficult to control. Diking and dewatering were used extensively in Kentucky reservoir for mosquito control by the Tennessee Valley Authority.

Environmental Manipulation Methods : Water Level Management

The major strategy of mosquito control following impoundment is the water level management. Today, water level management alone controls anopheline mosquito production on most of the 30 major Tennessee Valley Authority (TVA) reservoirs.

There are four phases of activity schedule:-

a. The first phase involves filling the reservoir to provide a surcharge of 30 cm or more above normal full pool, followed by a rapid draw to full pool level.

b. The second phase involves the maintenance of relatively constant full pool level at the clearing line until the beginning of anopheline mosquito breeding picks up. The constant pool level limits invasion of semiaquatic marginal vegetation into the fluctuating zone, thus providing a clear shoreline when the water is drawn down later in the season.

c. The third phase consists of weekly fluctuations starting when larval populations reach significant numbers. This calls for the lowering of the pool about 0.3 m and refilling during the week. The purpose of the fluctuation is to draw down the water level and expose the marginal band of vegetation once a week, thus eliminating the larval habitats. The anti-mosquito action is threefold. It creates unfavourable conditions for oviposition. It interrupts the production of food organisms for larvae, and it exposes larvae to predation by their natural enemies.

d. The fourth phase of the ideal water level schedule consists in combining seasonal recession and cyclical fluctuation. After a few weeks of the third phase (water level fluctuation), field observations and measurements of mosquito density levels will show that a clean margin is no longer provided at the low point of the cycle. The pattern of level fluctuation must then be changed. The water level is lowered by 0.3 m as before, but is subsequently raised only 0.27 m on reflooding. This is referred to as ‘seasonal recession’ since the period coincides with the decrease in stream flow and the increase in the use of water for downstream navigation flow augmentation and irrigation. The controlled recession serves to ensure that the low point of the weekly cycle will draw the water sufficiently far below the advancing vegetation to control mosquito production. If stream flow and withdrawal rates permit, the recession rate per week should be kept to a minimum since sharper the recession the broader will be the band of marginal plants requiring some shoreline maintenance before the flood storage phase begins a new.

SHORELINE MAINTENANCE

Marginal Drainage

An effective system of reservoir marginal drainage must be maintained if full advantage is to be taken of the strategy of water level fluctuations for mosquito control in impounded water.

Drift Removal

If storage for a flood surcharge is available, the problem of annual drift removal is minor and concentrated in the heads of bights and indentations where a cleared space should be provided for stranding the material. Such accumulations are usually piled and burned.

Shading by Tree Planting

Shallow waters exposed to direct sunlight have a more abundant growth of emergent and microscopic plants, thus providing necessary food and protection for mosquito larvae. Most important vectors of malaria prefer some sunlight. Shading by tree planting has been demonstrated to be useful in the control of anopheline species.

Artificial Flooding

The aim of vegetation control by flooding is to keep the seeds and germinating material under water to prevent germination or sprouting.

Water Treatment Plants

The environmental modification as well as manipulatory methods would be necessary at the site of water treatment plants not only in respect of site management but also in treatment unit management.

SITE LOCATION AND MANAGEMENT

Site Location

While choosing the site, one should keep in mind that at various stages water is liable to leak or seepage may occur which should not accumulate to form stagnant pools. There must be an easy natural drainage from the site. It should therefore be located in comparatively high and dry land with easy drainage to the surroundings. The nearest inhabitation would be at least 3 km away, the usual maximum flight range of gravid female.

Valves and control units attached to sedimentation units, filter house, etc. pose problem for mosquito breeding:

1. The valves/controls may leak slightly and the leaked water is kept logged in the valve chamber forming a stagnant water pool.

2. The valves leak profusely leading to overflow which creates a marshy pool where mosquitoes can breed.

3. Some of the valves are not enclosed in a valve chamber and are over the ground. These valves, when leak, create marshy pool.

The first set of activity would be to prevent such leakages by proper maintenance programme. Even then a proper drainage arrangement for such control units should be an integral part of construction. In the 2nd and 3rd cases a surface drain leading to the existing main drain could be one solution. Alternatively, the surplus water can be channeled and eventually piped into a seepage pit, where water table is high. A sketch of two kinds of seepage pits is presented in (Fig- 8.5).

Clear Water Storage Tanks

The underground or elevated public water reservoirs are often found to encourage mosquito breeding. This is more so with the underground reservoir with submerged inlet. Usually these reservoirs are closed and are not accessible to the mosquitoes. But there are a number of ventilation pipes in a large underground reservoir. The mosquitoes can have access through these and breed if the water level is fairly uniform and does not rise or fall rapidly. In such cases *An.stephensi* would form the principal breeder.

The control strategy would be based on environmental manipulatory methods. The best method is to provide mosquito proof wire gauge or nylon nets fitted over the mouth of the ventilating pipes.

The alternative measures would be to create

artificial agitation in the surface by blowing air, etc. If the inlet has a free fall with sufficient surface turbulence the chances of mosquito breeding would be lesser.

Water Transmission Line from Clear Water Tanks to Service Reservoir to Consumers and Public Taps

In case of leaking pipes the control measure would comprise of drainage of this water and elimination of small pot holes or hollows or depressions around such leaky or potentially leaky joints or control units. The surplus water from valve chambers of such a sluice valves should drain through the existing Kerb drains leading eventually to the storm sewer through the yard gully. In case the units are far away from it, passing through a peri-urban complex or where there are underground drains, the wastage may be disposed of overground through a soakage pit (Fig- 8.6 Fig- 8.7 and Fig-8.8).

Public Stand Posts and Fire/Garden Hydrant

Leakage in public stand posts and fire hydrants has possibly become usual phenomenon. In some of the towns even the faucets of the public stand posts are missing. Profuse wastages as leakages as well as the used waste from the public stand posts are required to be adequately drained so that no stagnant pool is allowed to form. The other requirement is that the apron must be in proper order with adequate leadway drain.

The fire hydrant covers must always be present in addition to adequate arrangements for drainage. Similarly garden hydrants also tend to leak. Soakage pit would be required.

Domestic Storage

The mosquito breeding potential in domestic storage systems is enormous, particularly because of apathy and lack of knowledge amongst the consumer.

Possible Sources

a. Underground and overhead tanks for storage of water.

b. Other uncovered water containers.

c. Ornamental tanks with or without fountains.

d. Water-pools in the kitchen garden.

e. Flower-pots

f. Water storage at construction sites like brick curing tanks, lift pits, etc.

g. Badly constructed ornamental terrace.

h. Wells

Remedial Measures

The control measures for controlling water loggings in such areas comprise of environmental manipulation mainly :-

For water tanks and cisterns jet water agitation eliminates *An.stephensi* and in addition mosquito proof nets as described in public reservoirs may be installed (Fig - 8.9).

The other water containers can be effectively controlled against mosquito production by dewatering it completely once a week and cleaning the same. Similarly the flower pots may be dewatered once a week to get rid of mosquito breeding from them.

For ornamental tanks with fountain, the jet of water may eliminate the possibility of larvae generation due to constant agitation of the surface produced by the fountain jets whereas the ornamental tank without jets would invariably invite *An.stephensi* breeding. Biological methods effectively control the situation. Top feeding larvivorous fishes like *Gambusia* and *Guppy,* can be cultured in those tanks or fountains for effective control of mosquito breeding. For abandoned wells similar biological control methods with *Guppy* and *Aplocheilus* could be very effective. For wells, not in use at all, expanded polystyrene beads are very effective.

For badly constructed ornamental terraces which may trap some water and eventually form breeding ground for *An.stephensi* the only solution is to repair the same so that water is not held

up there. Usually a good outlet will serve better.

For water storage at construction sites, curing tank, etc. water is let out once a week or once in 10 days or filling the tank immediately after the construction.

Water Used for Commercial and Recreational Purpose

In the commercial establishments and in factories in various units, water is stored for a long time for curing purposes, etc. If it is impossible to drain and fill within seven days as per the process, biological methods like use of larvivorous fish can be made provided the water is conducive to fish survival or the fish do not hamper the process.

Swimming Pools

Swimming pools in use probably do not need any mosquito control measures. But long unused swimming pools need care by completely replacing the water once every seven days.

Ground Water - Wells, Tubewells - Hand Pumps

The waste water from the tubewells fitted with hand pumps is required to be dealt within similar manner as discussed under public stand posts. The water logging problem is required to be essentially obviated from mosquito breeding point of view.

Necessarily the maintenance of the tubewells or well platform should receive priority not only from sanitation point of view but also from the point of view of elimination of small water pools that may favour mosquito breeding.

The tube-well/well platform should slope towards the periphery from where the waste water would be captured by a lead way drain and carry it to the general road drainage system. (A typical tube well platform with drain is shown in Fig- 8.10).

In the peri-urban regions, the waste water can be disposed into a soakage pit or in favourable geographical formations, vertical drainage may also be envisaged (vide Fig- 8.11).

CONCLUSION

In the end it may be impressed that the bio-environmental methods of control, as would be best suited in combating mosquito/malariogenic problems arising in water supply system, would largely depend upon the intersectoral coordination as well as people's awareness. The consumers participatory programmes would deliver the best results. But all this will in turn, depend upon the motivation of the people as well as the various planning and implementing agencies.

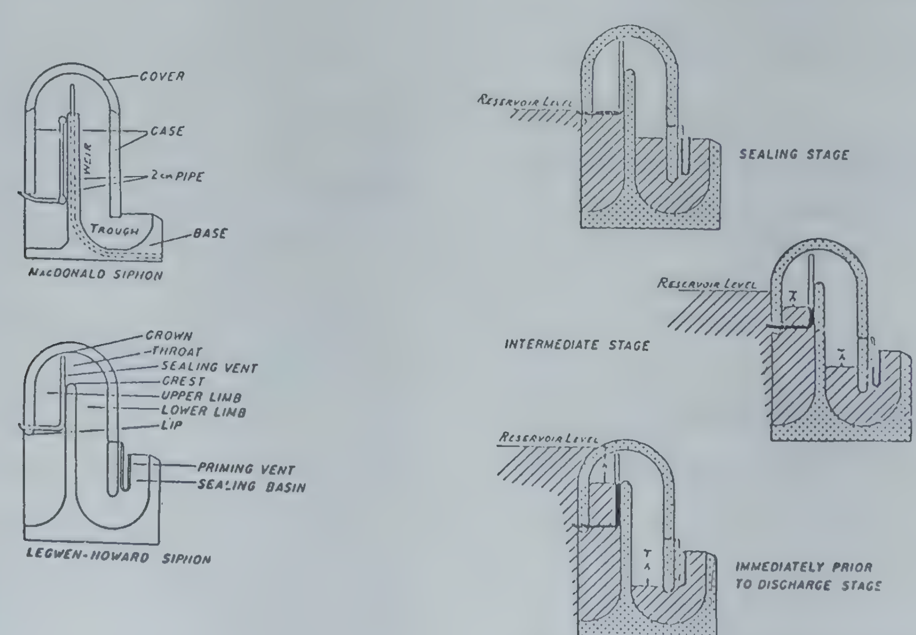


Fig- 8.2 : Basic Types of Self-priming Siphons used for Periodic Stream Flushing for Malaria Control

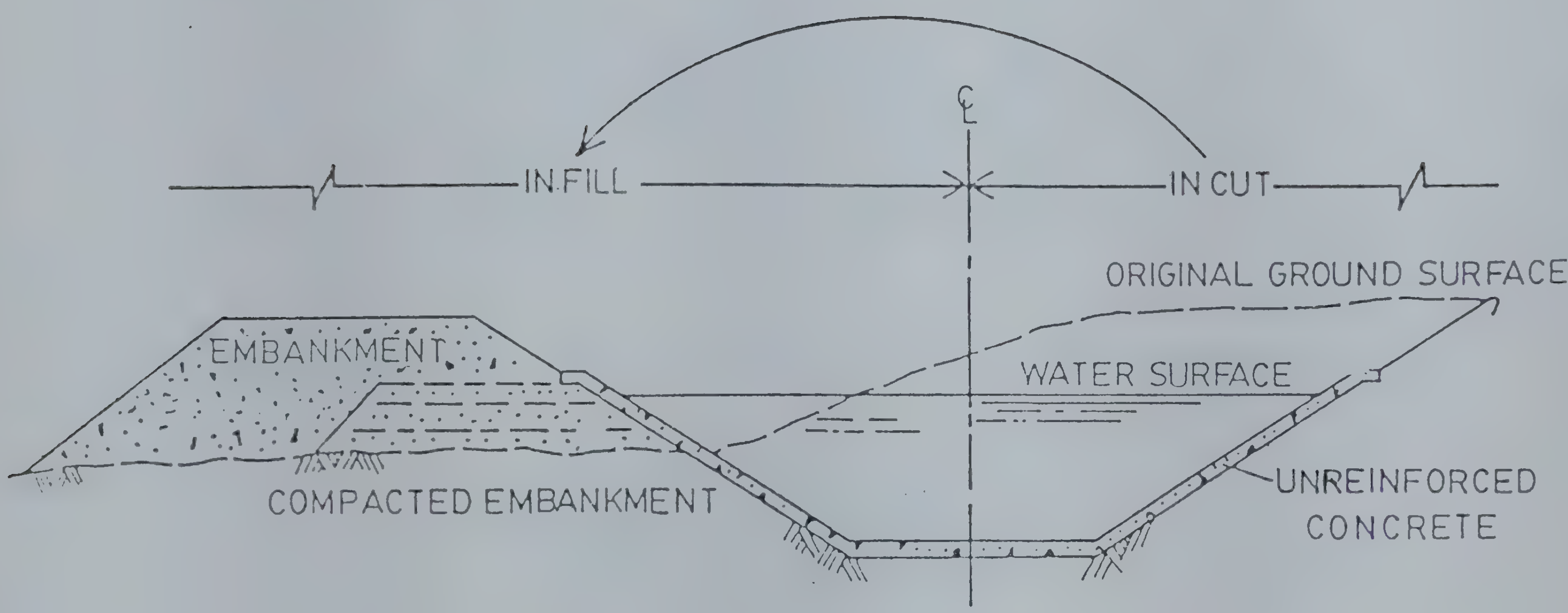


Fig- 8.3 : Bottom Contours of Drains

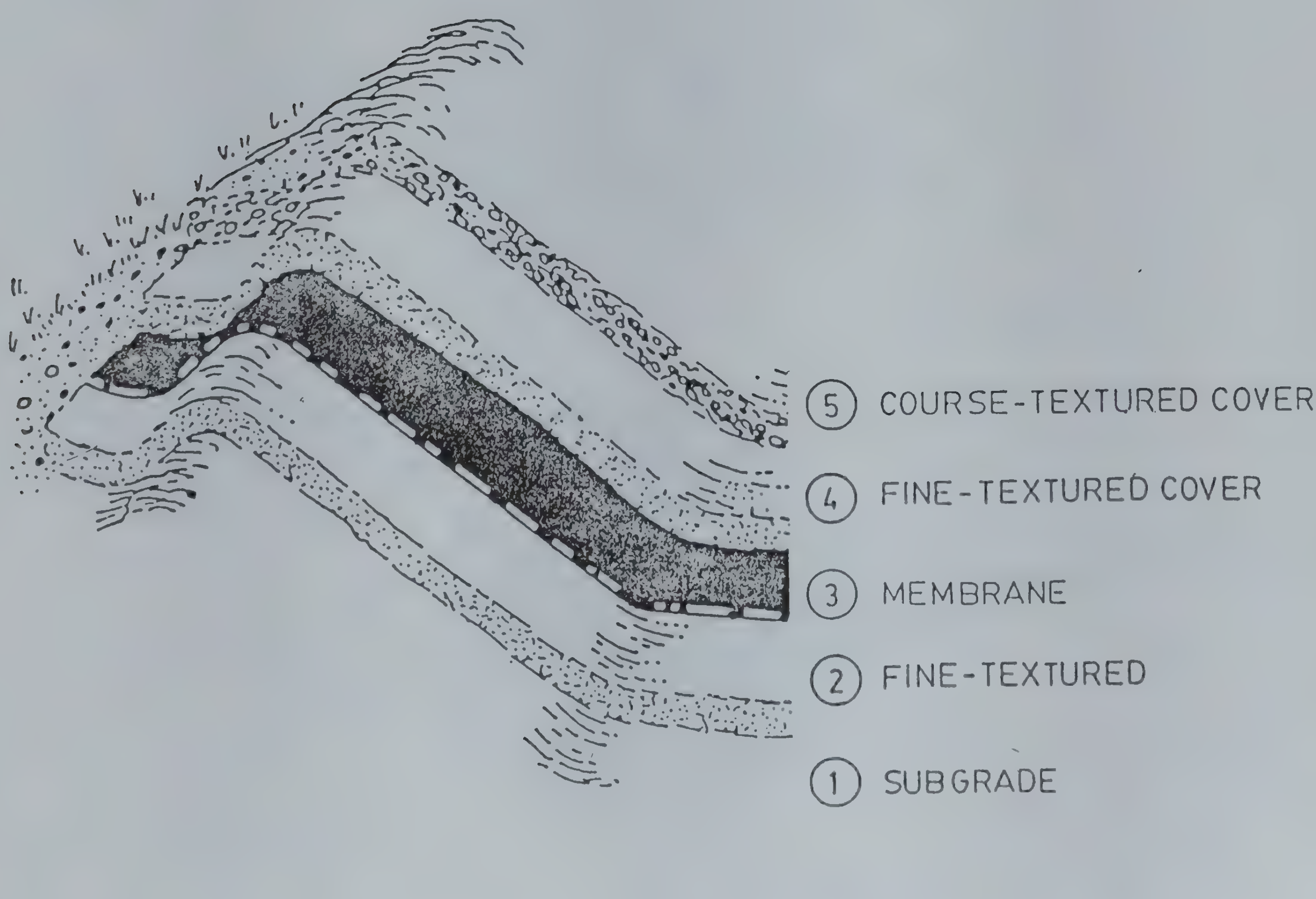


Fig- 8.4 : Section of Canal Showing Membrane Lining

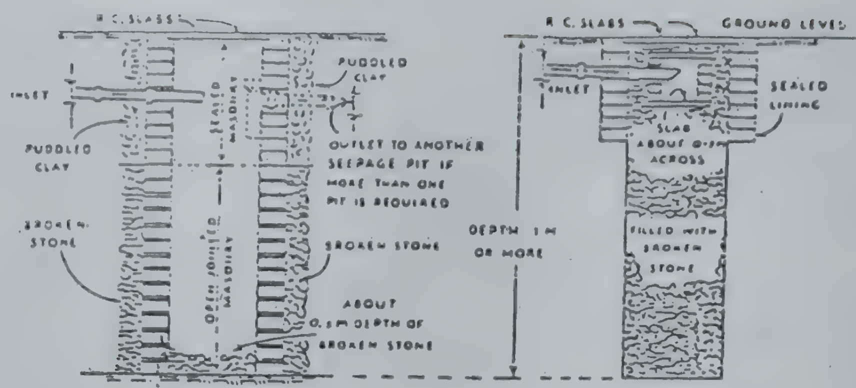


Fig- 8.5 : Two Kinds of Seepage Pits. (Adapted from : Ross Bulletin Xc. S, 40)

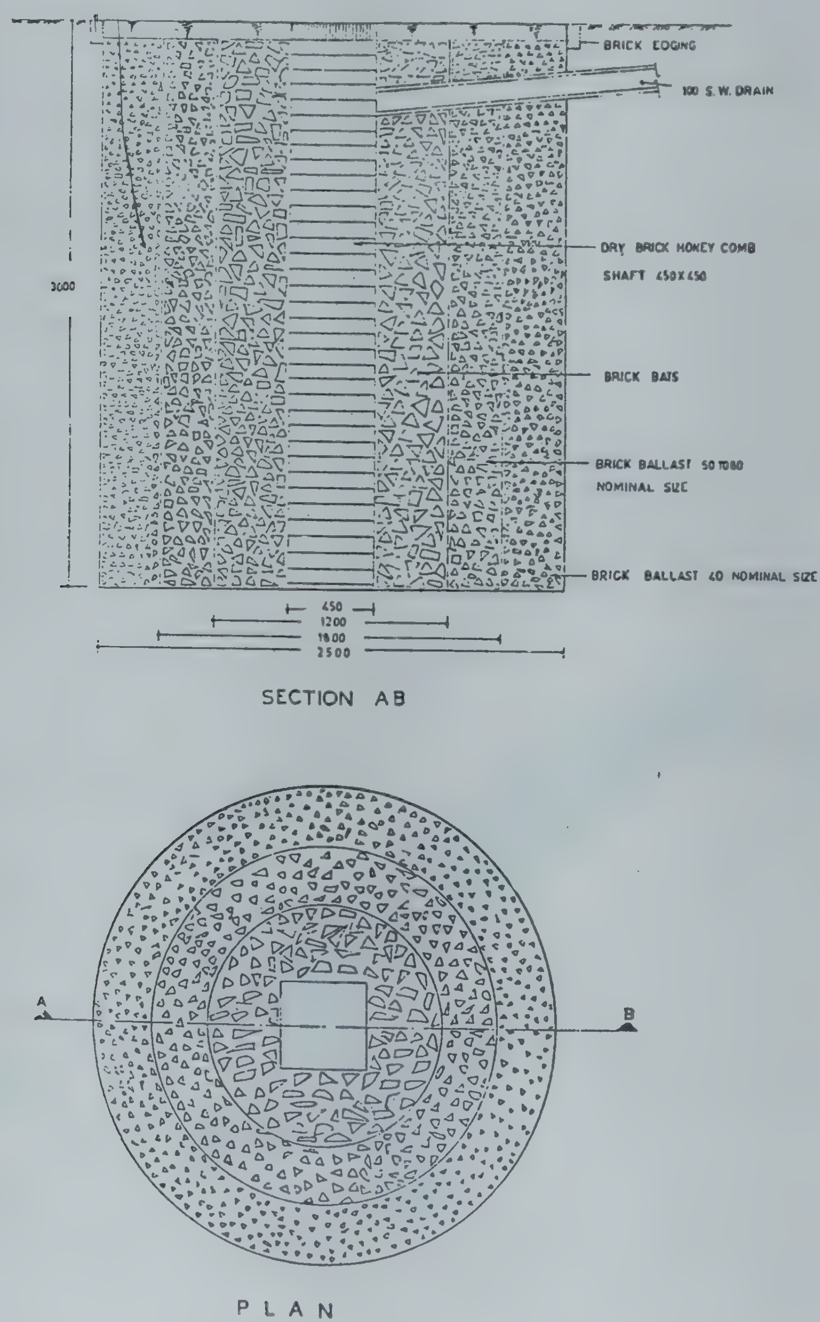
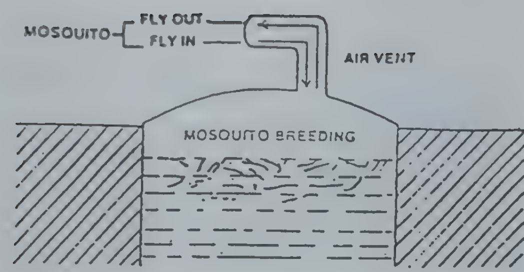
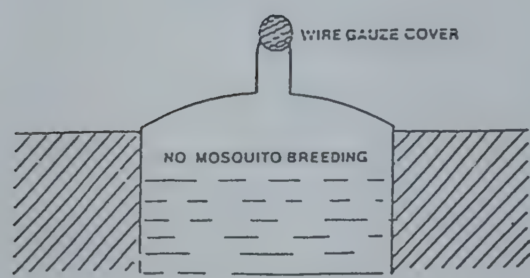


Fig- 8.6 : Soak Pit



(Lateral View)



(Front View)

Fig- 8.7 : Mosquito Proof Net in an Underground Reservoir

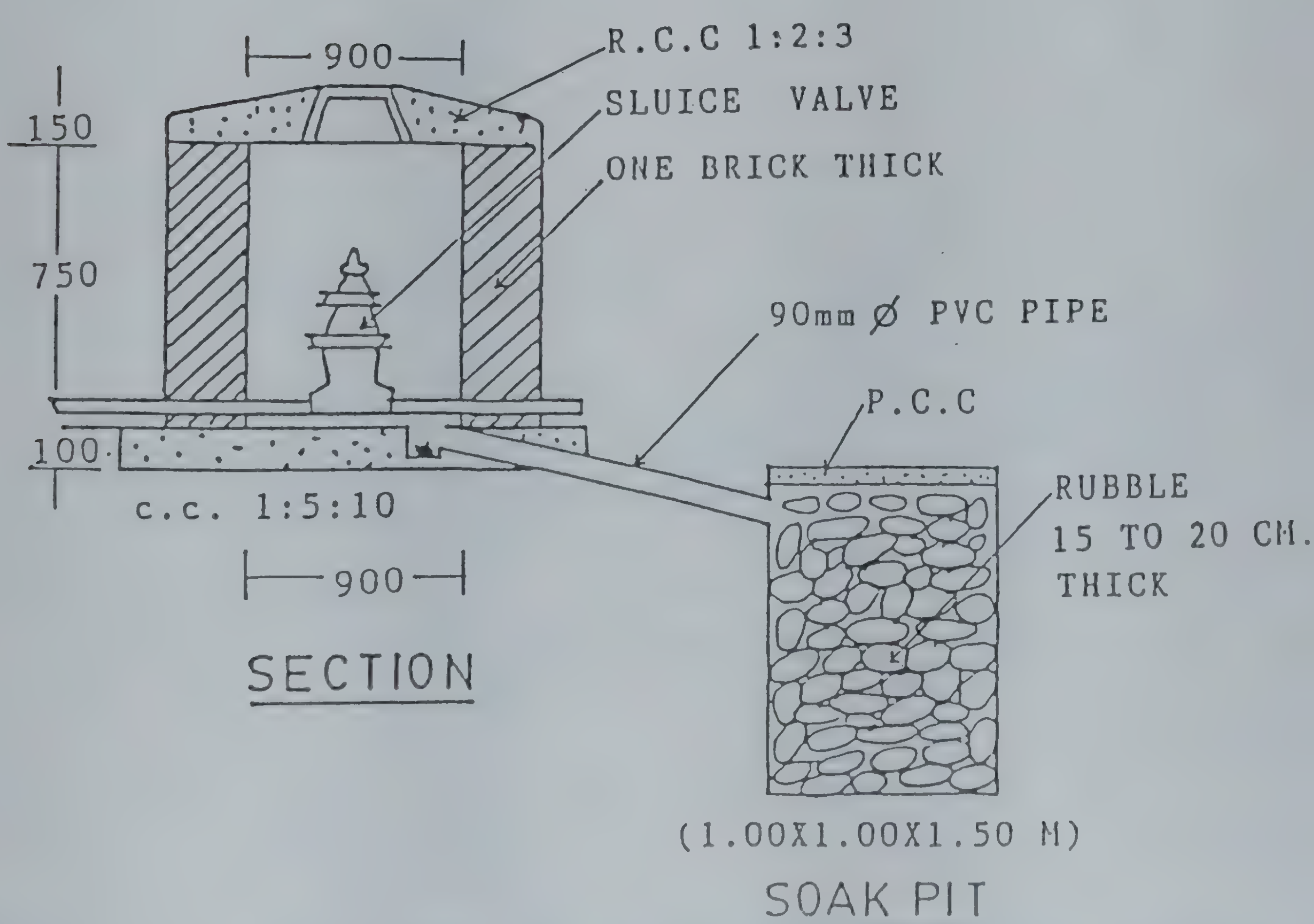


Fig- 8.8 : Design for Masonry Chamber & Soak Pit for Sluice Valve and Water Meter

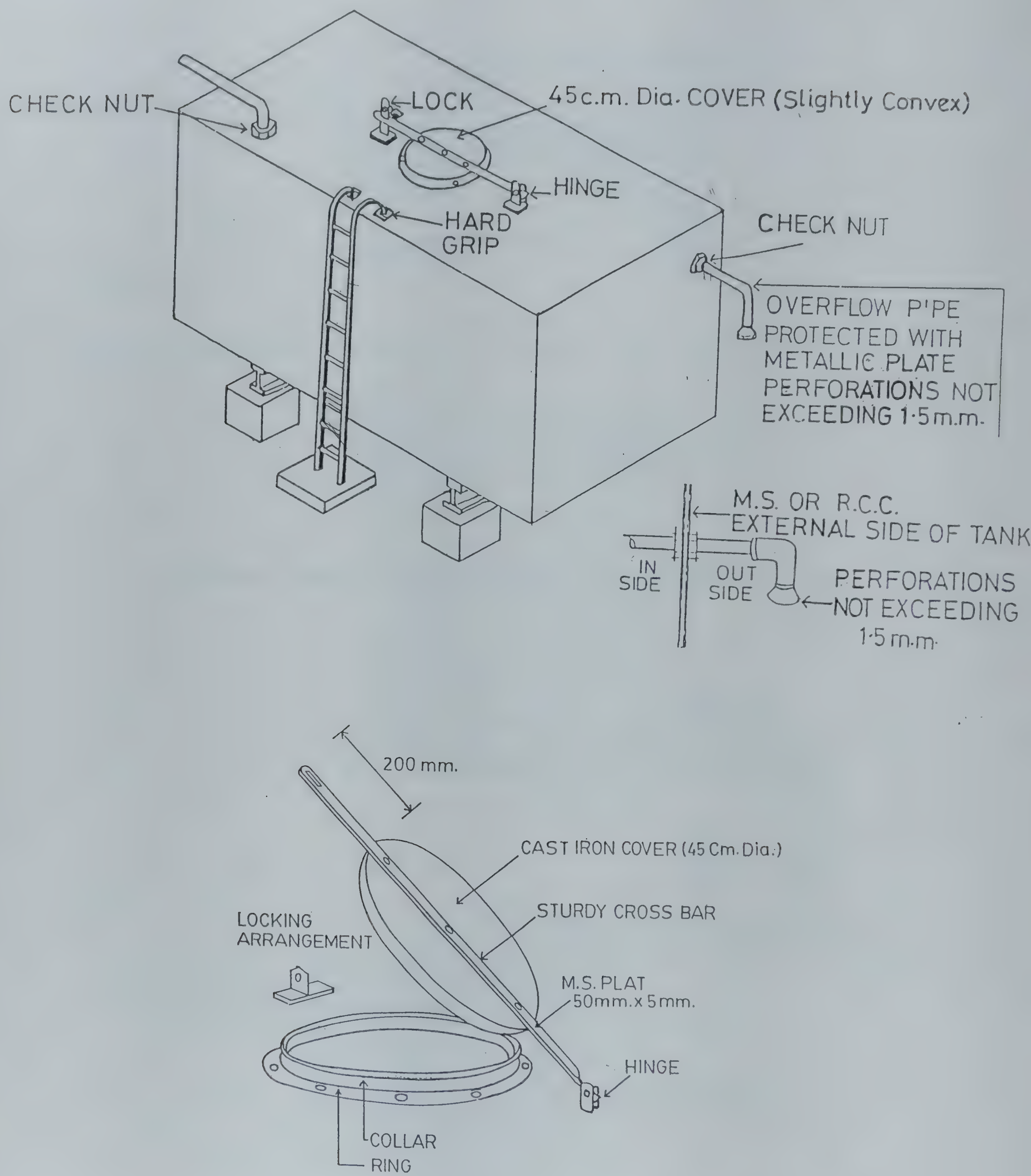


Fig- 8.9 : Standard Design of Overhead Tank with Cover Design (Bottom Figure) for Mosquito Proofing of OHTs/Wells/Cisterns

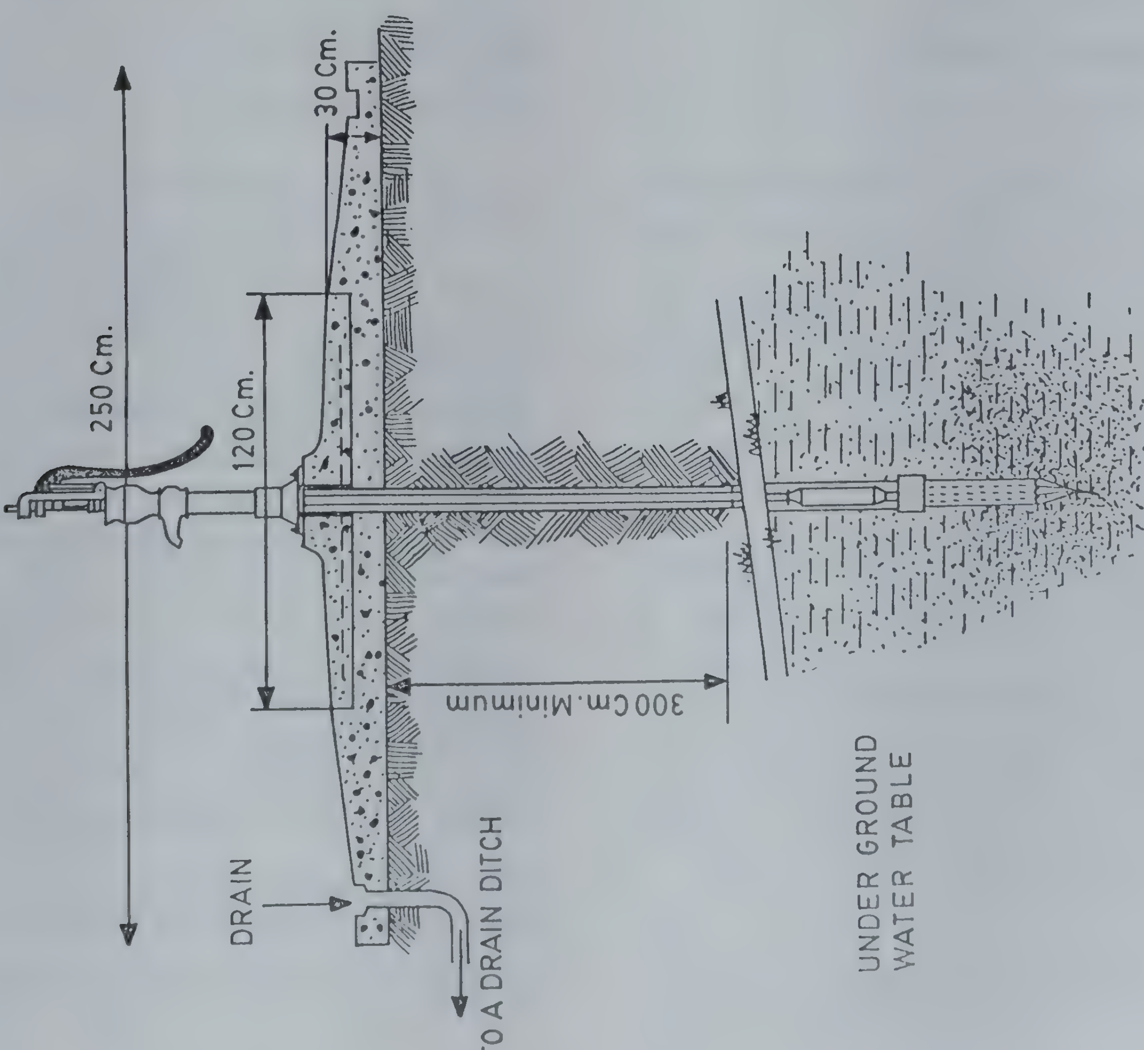


Fig- 8.10 : Tube Well and Hand Pump

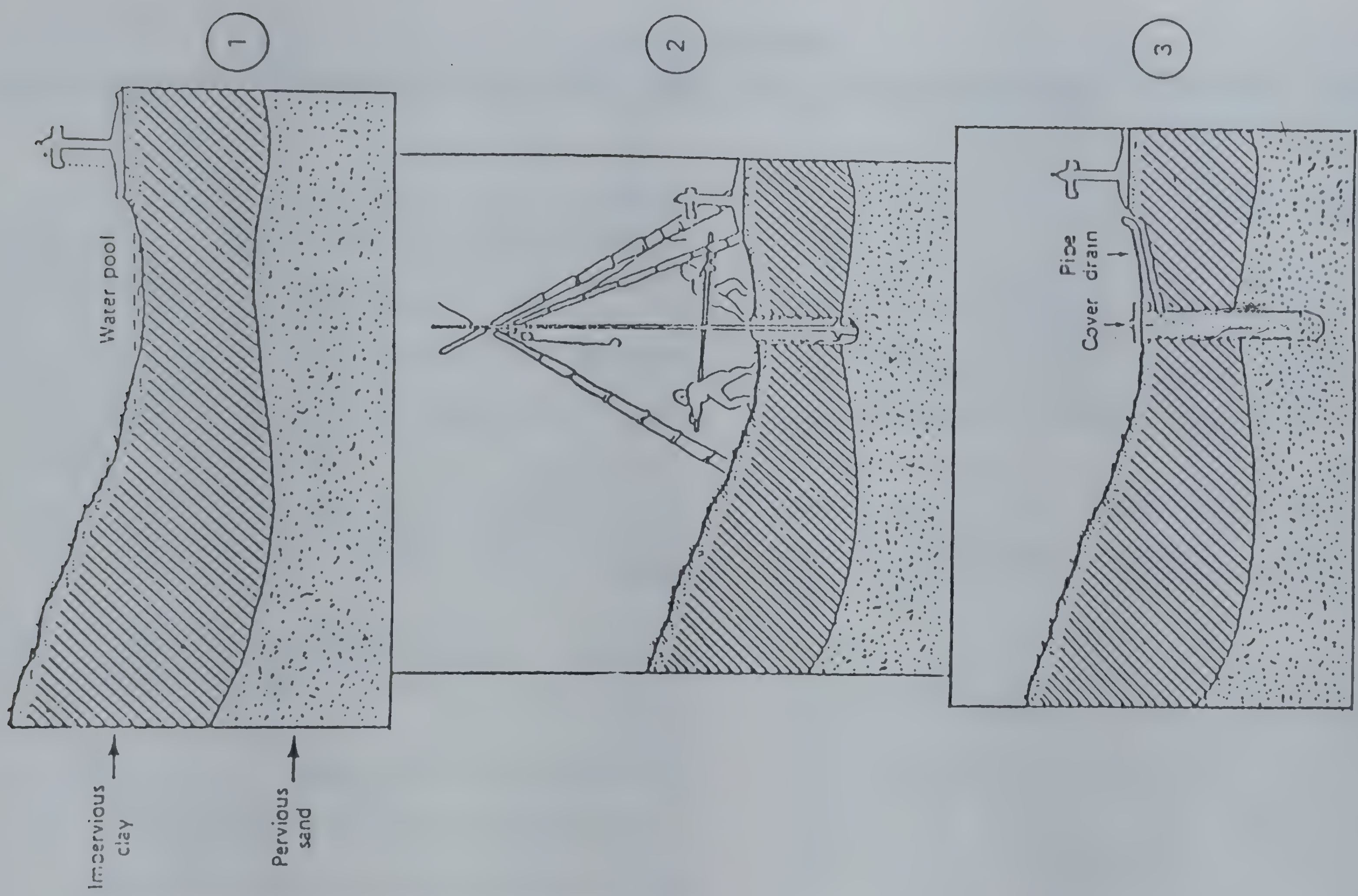


Fig- 8.11 : An Example of Vertical Drainage

SECTION-3
URBAN WASTE WATER DISPOSAL AND MOSQUITOGENIC CONDITIONS

INTRODUCTION

It is estimated that in India daily water use in urban areas is between 50 and 300 litres per capita and it is more for industries. About 80 to 90% of this water is returned as 'spent' or 'waste' water which requires carefully planned disposal.

Proper sanitary disposal of 'waste' water i.e. sewage, sullage and storm water is a key factor in prevention, elimination or reduction of larval habitats of the vectors of human diseases like filariasis.

The objective of municipal drainage being disposal of waste water is compatible with that of mosquito control as a properly designed waste water management system eliminates almost all mosquito breeding places. However faulty design, poor construction and inadequate maintenance increase mosquitogenic potential.

TYPES OF WASTE WATER

Sewage

Characteristics and volume of domestic sewage will depend on the quantity of night soil as well as volume of water used by the population. Additionally some ground water infiltrates into the sewerage system, and a portion of storm water may also find its way into this system through unauthorised roof-water connections.

Sullage

Sullage, also known as greywater, is domestic spent or waste water not containing excreta. In developing countries there are financial and other difficulties associated with providing water borne sewerage systems, consequently there is an increased interest in dry or on-site techniques such as improved pit latrines, two pit P.F. latrines, composing toilets or cartage system.

Storm Water

Collection and disposal of rain water poses serious health problem, particularly vector breeding in congested urban areas. Quantity of storm water depends on the amount of rainfall, run-off characteristics of the catchment area and the drainage system design. Earlier, the practice was to have combined drainage system for storm water as well as sewage/sullage. But modern engineering practice recommends a separate disposal system for storm water which is much less polluted as compared to sewage or sullage water.

TYPE OF DRAINAGE SYSTEMS FOR WASTE WATER IN URBAN AND PERI-URBAN AREAS

Drainage system may consist of :

i. Burried or underground conduits

ii. Open surface drains, lined or unlined

iii. Subsoil drains

iv. Vertical drains

v. Outfall canals/streams

Sewage/sullage and rain water accumulating in yards and in road-side ditches are best cleared by organised underground drainage system, supplemented in some situations by open lined storm water drains. In India, major metropolitan cities have underground sewerage system for the core-city areas and open drains in the peri-urban and sub-urban areas. However, most of the small and medium towns are being served by open drains. Out of 3,150 towns in India, only 217 have underground sewerage system, that too partly and majority of them do not have proper treatment and disposal plants.

Open Surface Drains/Outfall Canals

The earth canal is still the most commonly used structure for conveying waste water in sewer outfalls. It is one of the oldest and simplest engineering works for water resources

development. In small and medium towns shallow open drains are used for carrying sullage and storm water.

The cross-section of earth drain or canal should usually be trapezoidal, with the sides as steep as the material will stand when exposed to flowing water. The slope of the sides (ratio of horizontal to vertical projections) varies from 3:1 to 1:1 depending on the soil characteristics. The central section or bed of the canal is horizontal in a newly dug channel and earth canals should be stable.

The only advantage of earthen drain or canal is their low initial cost and easy construction and it has many disadvantages like seepage, spillage, erosion, etc.

Underground/Buried Conduits

Pipes or closed conduits are ideal for conveying sewage/sullage or storm water. The carrying capacity of the pipelines, under pressure, can be further increased without producing undue stresses that may cause leakage at the joints. Therefore, if there is a need to convert existing canals, it may prove economical to replace them with closed conduits rather than to line them in open sections.

The principal disadvantage of pipe conduits is a). high cost b). maintenance.

Design of Drainage System

The design of drainage system involves precise calculations of water to be carried. The reader may refer to Manual on Sewerage and Sewage Treatment, published by CPHEED, Ministry of Urban Development, Government of India.

Velocity of Flow

The water velocity in open channels as well as in underground conduits under gravity flow conditions depends on three factors:

1. Hydraulic gradient
2. Geometry of the cross section ; and
3. Roughness or smoothness of the channel surface

The flow velocity in a drainage channel is usually designed to avoid either undue erosion or excessive silting - self cleansing velocity. The minimum velocity for preventing deposition and clogging of drain channels is 0.9 m/sec. The maximum velocities safe against erosion are given in Table- 8.1.

Table- 8.1: Maximum Velocities Safe Against Erosion

Type of Soil	Maximum Velocity (m/sec)
Very fine loose sand	0.23 - 0.30
Fine loose sand	0.30 - 0.45
Coarse sand or light sandy soil	0.45 - 0.60
Average sandy soil	0.60 - 0.75
Sandy loam	0.75 - 0.85
Average loam, alluvial soil, volcanic ash	0.85 - 0.90
Firm loam, clay loam	0.90 - 1.15
Stiff clay soil, ordinary gravel soil	1.20 - 1.50
Coarse gravel, cobbles, shingles	1.50 - 1.85
Conglomerates, cemented gravel, soft slate, tough hard-pan, soft sedimentary rock	1.85 - 2.45
Hard rock	3.00 - 4.50

Cross Section of Drain

There are three ways to increase the mean velocity in an open channel: (**a**) by reducing the roughness (**b**) by increasing hydraulic radius and (**c**) by increasing hydraulic gradient. As regards hydraulic radius, the most efficient canal section is semi-circle with open top. Trapezoidal section is the second best which is preferred because of easy construction and reduced cost. Rectangular channel is the least efficient. Different cross-sections of drains are given in Fig- 8.12 Fig- 8.13 and Fig- 8.14.

To facilitate malaria control operation, it is frequently desirable to use a drain with a narrow bottom width or a 'V' cross section, so that during lean flow period, the flow will continue within the

narrow cross-section without becoming a meandering channel at the bottom where mosquitoes could breed.

Lining of Ditches/Canals/Surface Drains

In the urban and peri-urban areas unlined open drains and canals have become the principal sources of mosquito breeding because of **i**. weed growth, **ii**. inadequate velocity, **iii**. intermittent and erratic flow resulting in pockets of stagnant pools of water.

Lining of canals and drains would prove to be cost effective in the long run.

Urban Drainage Problems: Special Consideration for Mosquito Control

As the purpose of drainage is to remove unwanted water from land surface thus eliminating mosquito breeding sites, it is in principle compatible with mosquito control. However mosquito problems do exist and enhance due to improperly designed poorly constructed and inadequately maintained drainage system. In principle, the radical solution to the problems is to avoid the use of open ditches and if this is not possible, maintain the drains in good condition. Specifically the following environmental management measures should be given due consideration and incorporated in the design ;

a. Use of underground conduits instead of open designs, as far as possible.

b. Lining of the drains and lining of the invert if open ditches have to be used.

c. Good alignment of drains and avoidance of sharp curves.

d. The flushing of drains, canals and outfall streams.

e. Maintenance of adequate self-cleaning velocity by avoiding undue deposition and silting.

f. The water velocity at the edges should exceed 0.6 m/sec as at this velocity larval breeding is controlled. However it should not be confused with average velocity or self cleaning velocity.

g. Effective collection and disposal of domestic sullage water.

h. Effective collection and disposal of solid waste, so that they are not instrumental in blocking open drains and sewers thereby causing pockets of stagnant water where mosquitoes can breed.

i. Preventive and corrective maintenance of open drains and underground sewers to prevent water logging in the urban areas.

Sullage Disposal

There are five kinds of sullage disposal: casual disposal by **i**. tipping waste water receptacles in the yard, **ii**. garden watering; **iii**. site disposal by soakway; **iv**. drainage into open drains; and **v**. drainage into covered drains or sewers. Each of these has different health implications.

Tipping in the yard may create breeding sites for mosquitoes as well as muddy and unsanitary conditions close to the dwellings. Sullage containing pathogens from babies bath water or adults ablution water may also infect children playing in the yard. In well-draining soils, where sullage quantities are limited or housing density is low, tipping of sullage outside the home is unlikely to be a major health hazard. However, where soil is less permeable and housing density is high, an adequate method of sullage disposal is essential.

Sullage disposal by use in vegetable gardens near the house is likely to create a few health hazards provided that prolonged impounding of waste water is prevented. Sullage disposal by soakway entails a low risk of ground water contamination; the risk of microbiological ground water pollution is much lower with sullage than it is with sewage. The same is true for high nitrate pollution.

Drainage of waste water into open drains, perhaps into storm drains provides the most readily identifiable health risk, namely that of promoting the breeding of Culicine and other mosquitoes. In areas of year-round rainfall, storm drain will contain water continuously. If they are kept free of garbage and are well designed, the drains will flow freely and provide few sites for mosquito breeding and addition of

sullage will not affect community health. But in areas of seasonal rainfall and where the drains are liable to blockage and water stagnation the addition of sullage creates year-round standing water and thus year-round breeding where only seasonal breeding may previously have occurred.

Sullage may be disposed off into a sewage system. This disposal raises no special health problems or requires special treatment before discharge.

Solid Waste Management

As a result of inadequate and irregular collection of solid waste, it has often found its way to the open surface drains and chokes them. The storm water inlets and galley traps are also often blocked by the accumulated garbage and cause water logging. Until and unless the overall management of soil waste collection and disposal in the urban areas is improved, maintenance of drainage system can never be satisfactory.

Maintenance of Sewerage System

It is most essential to protect sewers and to preserve their capacity by prohibiting discharge into the system of waste that will damage the system.

Clogging of Sewers

The factors responsible for the clogging of sewers may be :-

a. Deposition of grit or other detritus.

b. Penetration of roots from nearby trees damaging the sewers.

c. Growth of fungi

d. Deposition of tarry materials

e. Improper working of pumping units.

Preventive Maintenance

Many of the causes leading to the clogging of sewers can be prevented by periodic cleaning and removal of silt accumulations in sewer line including manholes while the system is functioning.

Corrective Maintenance

Corrective maintenance becomes necessary for removal of obstructions in sewers.

Chemical Treatment

Control of growth of roots and slimes in sewers can be achieved by application of chemicals like copper sulphate.

Disposal and Treatment of Sewage : Consideration for Mosquito Control

A variety of unit processes combine to form conventional sewage treatment.

Well functioning and properly maintained conventional sewage treatment plant like activated sludge out trickling filters along with primary and secondary sedimentation and sludge treatment units are not likely to create mosquito nuisance. However, because of lack of proper maintenance and irregular functioning, water stagnation may occur in various components of the plant as indicated below, which may create sources for mosquito breeding.

i. **Sedimentation tanks:** non-functioning sedimentation tanks for long period

ii. **Activated sludge plants:** During the long period of power shedding or when sewage plants are put out of operation, water stagnation may occur.

iii. **Trickling filters:** The ventilator pipes of trickling filters should be provided with mosquito proof wire net.

iv. **Storm water holding tanks:** In case of combined sewerage system a large volume of effluent (a mixture of rain water and sewage) is retained in holding tanks prior to their discharge into natural water sources.

v. **Sludge drying beds:** During monsoon, wet sludge mixed with rain water may stagnate in sludge drying beds.

Mosquito Problems and Solutions in Low Cost Waste Water Treatment Units Like Stabilisation Ponds, Fish Ponds, Aerated Lagoons, etc.

The conventional sewage treatment has been found to be cost prohibitive for most developing countries. As such, low cost treatment units like stabilizing ponds, fish ponds and aerated lagoons are being increasingly used.

Fish Ponds

Pisciculture with sewage effluent or with raw sewage is being increasingly used as a method of waste water treatment and recycling. While in some parts of tropics and sub-tropics fish culture ponds with fresh or saline water constitute a breeding place for malaria vector, pisciculture with waste water may act as breeding place for culicine mosquitoes. Usually, low lying lands subjected to flooding during rainy season are chosen for fish ponds.

CONCLUSION

It is clear from the foregoing discussion that the waste water drainage and on site sanitation systems have the potential for greatly increasing the population of Culicine mosquitoes in tropical and sub-tropical towns and cities. Much of the problem is man made, rather contributed by the public health and water resource management engineers who are unconcerned about the health implications of their projects. Poorly maintained open drains, clogged underground conduits, flooded pit latrines, soakage pits and septic tanks have become synonymous with the urban environment in congested cities and towns of our country. Successful environmental management will largely depend on a carefully thought out combination of appropriate design and good maintenance of the drainage and on site sanitation facilities. It is important that engineers incharge of water supply and sanitation scheme should be appropriately oriented towards the entomological implications of their projects, so that they can design the facilities with least potential for mosquito breeding.

Standard design for mosquito proofing underground sewerage system like manhole cover and septic tank vent pipe are given in Fig- 8.15 and Fig- 8.16 respectively.

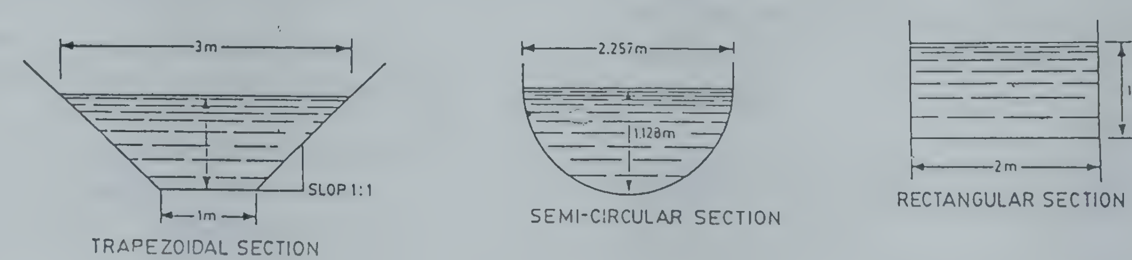


Fig- 8.12 : Bottom Contours of Drains

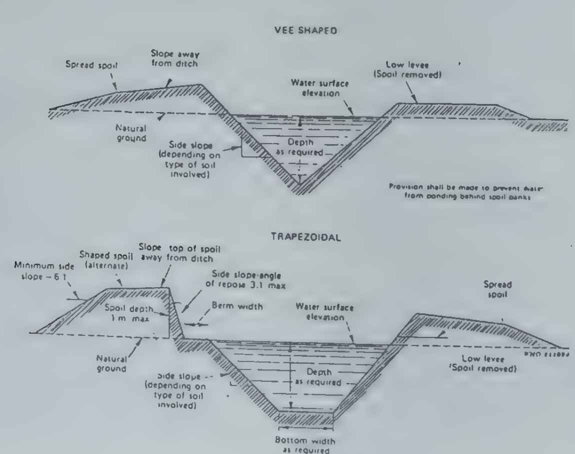


Fig- 8.13 : Two Typical Cross Sections of Drainage Ditches

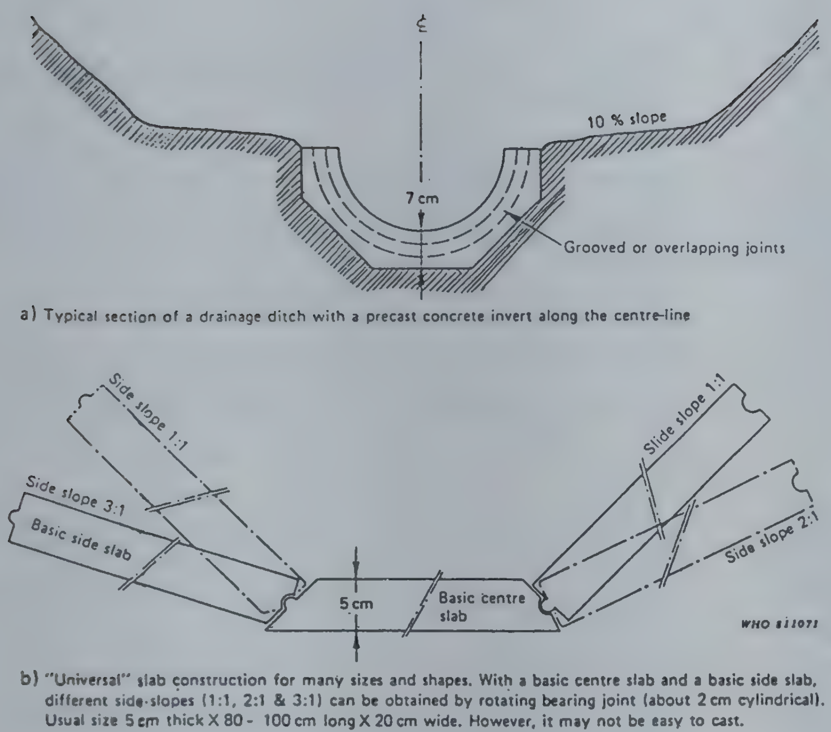


Fig- 8.14 : Precast Concrete Invert Sections

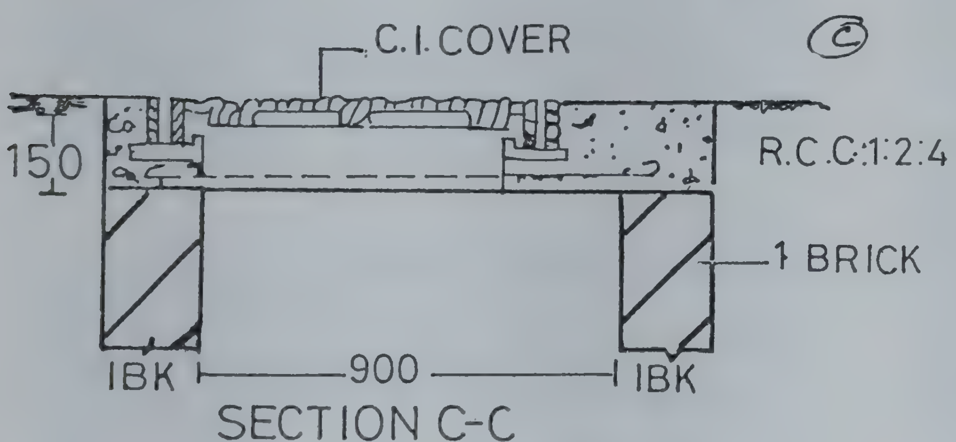


Fig- 8.15 : Design of Mosquito Proof Man-Hole

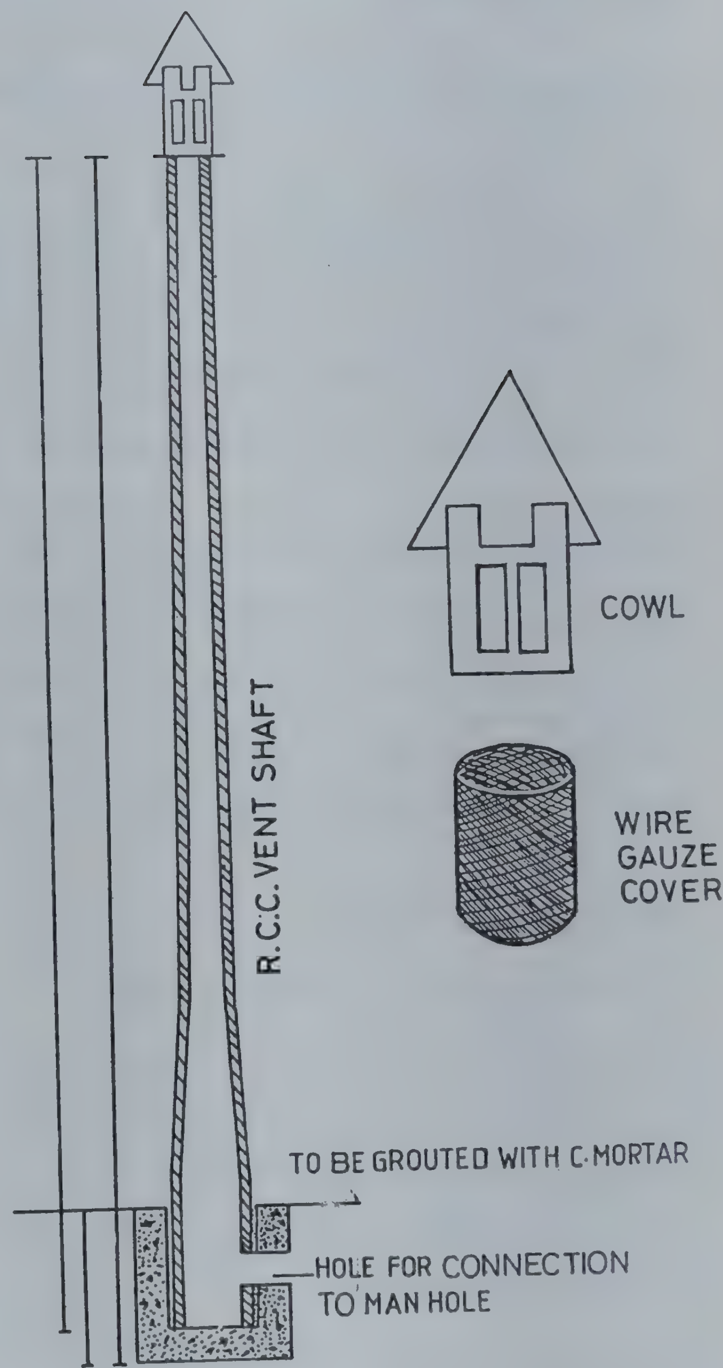


Fig- 8.16 : Mosquito Proofing of Cowl

SECTION-4
MALARIA AND MOSQUITOGENIC PROBLEMS DURING CONSTRUCTION OF HOUSING UNITS

High population density in urban areas aggravated by constant migration from villages as well as natural growth in rural areas has resulted in acute housing shortage. Paucity of funds results in a compromise with house construction parameters specially when additional structures are added to the existing houses. Present efforts are not able to bring relief due to lack of integrated planning which is a prerequisite for creating healthy human settlement.

Construction and Mosquito Menace

Though there are many other preconditions for transmission of malaria, it is well known that **the malaria vectors breed in any 'fresh water' pools which remain stagnant for more than 7-10 days.** However, at the construction site the engineering professionals can, with appropriate organisation and management, ensure that such pools of water are not created around the sites particularly during the transmission season.

Stages of construction

Preparation and Selection of Site

It is essential that planners inspect the site before advising its suitability for the intended housing settlement so that perpetual water ponds or swampy conditions do not affect the residents of the new colony. A good site for any housing settlement should be at a higher level with possibility of prompt drainage of storm and other spent water into any adjoining disposal network. In addition the surface water should percolate at a faster rate or drained along the natural ground water gradients. In case such a network does not exist around the site, it should be essential for a planner to ensure through contour survey and other means to locate and design appropriate waste water disposal system which will prevent collection of waste water or swampy conditions that may provide breeding ground for mosquitoes.

Site Preparation

Even at a well elevated site with good geological conditions, there may be problems such as an undulating terrain at the site which will require cutting and filling to provide proper gradient, which is illustrated in Fig. - 8.17.

Excavation for Earth Fillings

When for large construction sites earth is taken from borrow pits, it is advisable that they should be located at a distance from the proposed housing unit and their number is kept to minimum and they are of reasonable size so that these could be later converted into a permanent water body where mosquito breeding can be controlled through larvivorous fishes. The best solution however, is to dress the borrow pits by filling them up with debris ensuring proper gradient.

Site Drainage

Before any layout plan is taken off from the drawing board, it is essential to design the drainage and other waste disposal system for the settlement keeping in view all future demands.

Foundations

Depth of excavation for building foundation may vary from 50 cm to as deep as 2 m or more depending on soil characteristics and height of the building. Usually rain or underground seepage water may collect in these, creating new mosquito breeding sites. Mechanisation for construction of foundation may be adopted which may reduce the time gap between digging of foundation and the construction of building up to the plinth level. If foundation excavation is done during rainy season they usually get flooded with rain water and construction is temporarily stopped till this water percolates. The above problem can be taken care of if the foundation

excavation and construction of plinth is completed before the rainy season or is taken up after the rains are over. In case of serious compulsion when such foundation and excavation work has to be undertaken during the rainy season, it should be ensured that the water does not remain stagnant in these pits for seven days or more.

'In other words, it is recommended that as far as possible no construction below ground level should be commenced during the rainy season and if the construction has to be undertaken at all, it must be continued throughout the rainy season so as not to allow undisturbed water collection in the excavated pits'.

Construction of Super Structure

It has been often observed that having constructed the building up to the plinth level, usually some time is allowed to lapse before the ground enclosed by plinth wall is filled up and raised to desired level. Even with small rain, the plinth wall itself becomes the peripheral wall for any water collection.

The temporary water tanks are made mostly on every construction site and act as one of the main sources for mosquito breeding. Construction managers may take any of the following measures which would prevent mosquito breeding.

1. Instead of using stagnant water pools as curing tanks, the water may be kept running at least to create a surface velocity of 60 cm/sec, so that the malaria vectors cannot breed. This is usually costly and requires large quantities of water.

2. The other possibilities are to drain out the entire water from the curing tank on a seven day cycle. If this is also not possible, ripples may be created by beating the surface of water at close of work every day.

3. The construction programme may be so synchronised that the bricks submerged in the tanks are continuously utilised leaving no room for the water to stagnate. This causes disturbance in the water body during the process of loading and unloading of the bricks.

Curing of Walls and Cement Plaster

Adequate arrangements must be made so that the overflow water from curing of walls has a good outlet and does not stagnate around the building site.

Construction of Horizontal Components

Usually reinforced concrete or reinforced brick work is used for construction of lintel, canopy, flooring/roofing as also for cupboard and shelves. While preparing design of a building, it should always be kept in mind that any component if designed carelessly without objective functional consideration may lead to temporary/permanent water collection.

It is advisable that even for aesthetic reasons one has to design canopy displaying artificial thickness, it is preferable that the visual thickness is created by projecting an apron 'below' the ceiling of such projections or alternatively at least one of the sides of such upstanding fascia is left open with adequate slope to provide ample outlet for water. Due care should be taken to ensure that the overhead and other water storage tanks meant for use by the household are not only fully covered but also should be screened with wire mesh to ensure against access of the mosquito to the water body for breeding.

For floor traps located in kitchens and bath rooms, it is essential to ensure that the cover of the traps is never missing. One has to ensure that the lid of the trap is always in position and any such choking reported from around the vicinity should be immediately looked into to avoid ponding.

Finishing - Curing of Concrete Slabs, etc.

The better method of curing is spreading of gunny bags over the concrete surface and sprinkling water from time to time to avoid mosquito breeding. This is a better method as it ensures against ponding. Here it should be ensured that the surplus water flowing out of the slab is drained out of site adequately.

Curing of Precast Components

It is invariably observed that large curing tanks

exist at the construction site where prefabricated components are in use. These curing tanks again are a breeding source for malaria vectors. As suggested earlier, while designing these tanks we should be able to ensure that the tank is continuously supplied with water, so that it also overflows continuously into a well laid out drain or alternatively mosquito larvae are flushed by flooding and over flow once a week.

Equipments

The desert cooler left unused for a week or more with its water tank filled breeds mosquitoes. The equipment should be kept completely dry once a week to prevent mosquito breeding.

Organisation & Management

Building Construction Sites in Urban Areas:

A sizable percentage of the migrant labour force to urban areas consists mainly of unskilled labour, who find ready employment at the construction sites. The unbalanced economic growth only in a few urban centres of the country has put pressure on the land and infrastructure and large scale building activities scouring into the green suburbs and rebuilding/high-rise structures is a common scenario throughout these cities. The migrant labour force which provides the largest single manpower resource for carrying out these construction activities is usually employed on man-hour contract basis though their engagement continues for years.

Usually these workers' colonies adjoin the construction sites in the heart of the city and are devoid of any basic amenities. Worst conditions prevail as far as sanitation, water supply and drainage are concerned.

Legislation for Migration : Labour Camps

This particular problem not only exerts pressure on the existing urban infrastructure but causes epidemics of many diseases which were unheard of earlier in the local urban population. If the Government intends to prevent further deterioration, the most important piece of legislation should be to bring building industry under the organised sector thereby ensuring that construction industry is really in the hands of people who are not only committed but also who have organised and trained manpower besides adequate support equipment and infrastructure. Today most of the contractors win the contract, keep aside the profit and in turn give subcontracts for a part of the job to smaller groups with little or no background of construction management or organisation. This is evident from the fact that a number of buildings which were to be completed in Delhi during the ASIAD-82 are still incomplete and the workers who had settled in Jhuggi Jhopries (temporary hutments) around these sites are now living there for more than a decade.

Living Quarters for Construction Labour

The second action that the Govt. could take is to provide temporary living quarters to migrant labour to be built by contractors. These should be well planned with basic amenities. These temporary labour quarters should be removed immediately after the construction is over leaving the site clear. This is the usual practice in other countries around the world except in a few developing countries like India.

A number of low cost technologies, even for temporary applications, have been developed at CBRI for waste water. The research in developing an alternative system acceptable to community could have the following characteristics :-

a. It should involve all the individuals to maintain the system

b. Any negligence on the part of the individual should directly affect him and

c. Safe place for people to let out their anger and fear during meetings. It helps in depersonalised conflict and thus diffuses tension. It should be low cost and within affordable limits.

d. Its maintenance should be easy.

The waste water disposal system (Fig- 8.18) developed has all the above attributes. It can be precast as a single unit using ferro-cement technology. The salient features of the precast systems are:

Precast Ferro-Cement Unit

On-site construction is time consuming and requires skill of construction and quality control. An alternative developed using ferro-cement technology involves precasting of the chambers, which are installed through self help by undertaking the excavation of a bore hole construction, eventually lowering in position of the precast units.

The complete system, including the precast ferro-cement unit and the bore hole, costs about Rs. 450/- (at 1988 rates). A number of such units were manufactured at CBRI and were installed in villages around Roorkee and in the CBRI colony. Their performance has been satisfactory (vide Fig- 8.19).

Disposal of Human Waste

Effective sanitation is an important way of reducing the mosquito nuisance. It is, however, economically not feasible in respect of low cost latrine.

Hand-flushed water seal latrine seat proposed by Planning Research & Action Institution (PRAI), Lucknow and National Environmental Engineering Research Institute (NEERI), Nagpur (already adopted by the Bureau of Indian Standards) is recommended for adoption due to its low water requirement for flushing and low cost. The pits can be emptied for alternative use after lapse of every 3 to 5 years and the contents used as manure.

Size of Latrine

Anthropometric studies were conducted at CEERI to arrive at the optimum space requirement for the latrine cubicle. A size of 80 cm x 100 cm was found to satisfy most of the users. Therefore, 80 cm x 100 cm size is recommended keeping in view the size of brick available in the market.

Distance of Leaching Pits from Existing Buildings

Minimum distance of a leaching pit from an existing structure can be 85 cm for clay sand and 125 cm for sandy clays if the depth of the leaching pit goes 100 cm below the foundation of the building. The distance can be adjusted proportionately if the depth of leaching pit exceeds. The technologies profiled here are only a few which have been demonstrated in a number of places around Roorkee and have proved to be successful in reducing mosquito menace. Significant results can, however, be achieved only through integrated planning and large scale implementation through user's participation. The success of water mission should automatically work as a catalyst for malaria eradication mission, if the two are integrated at the Planning stage itself.

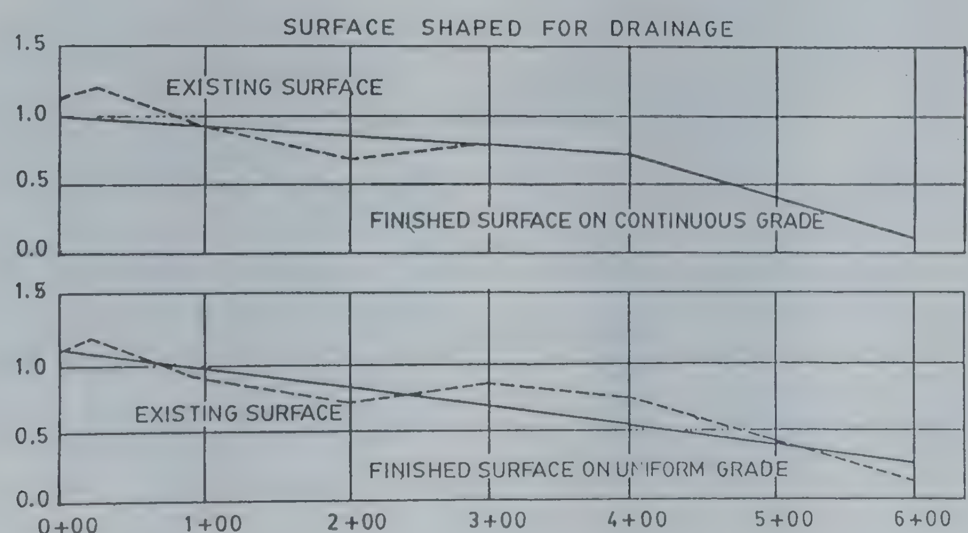


Fig- 8.17 : Surface Graded for Surface Drainage

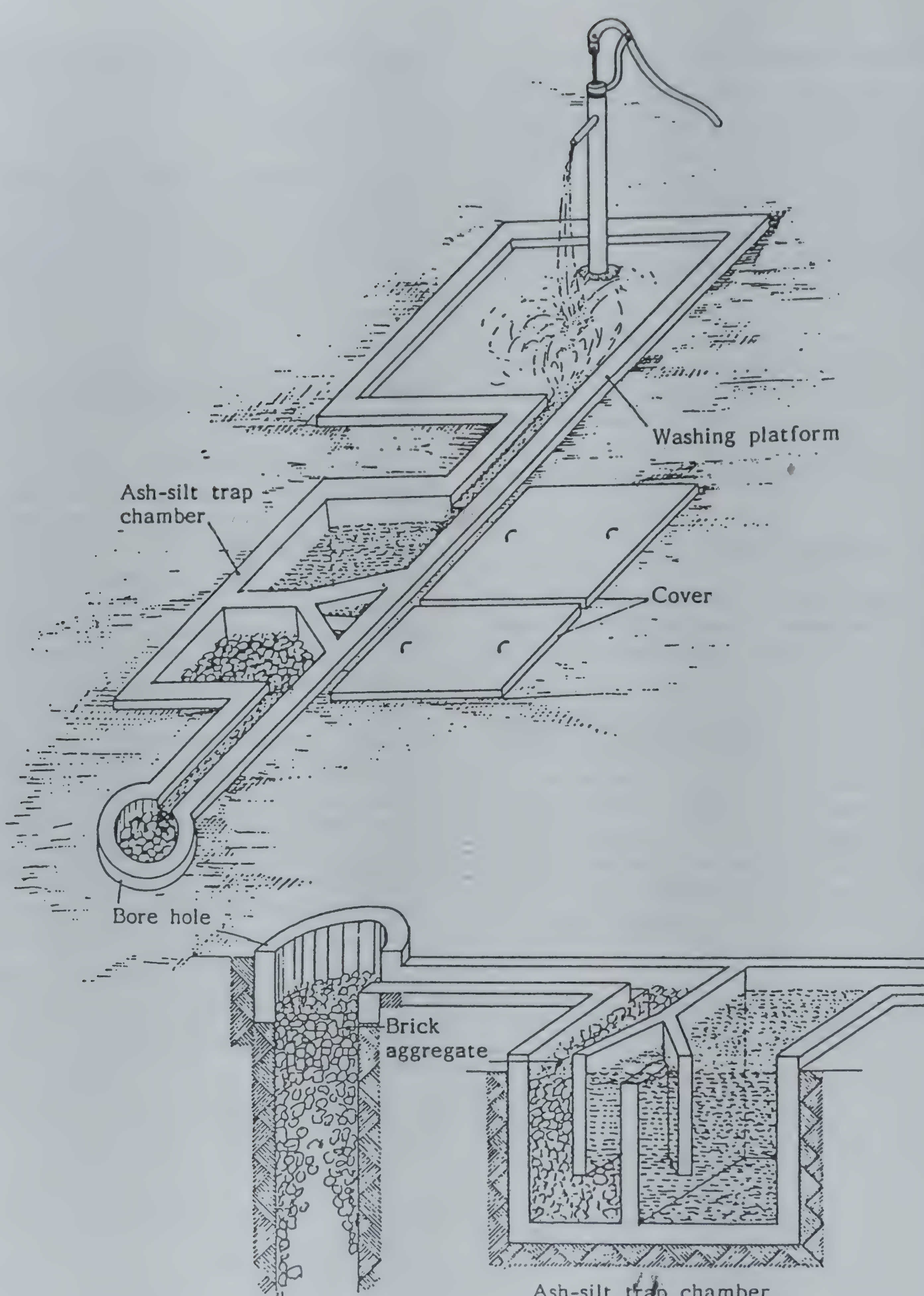


Fig- 8.18 : Waste Water Disposal System

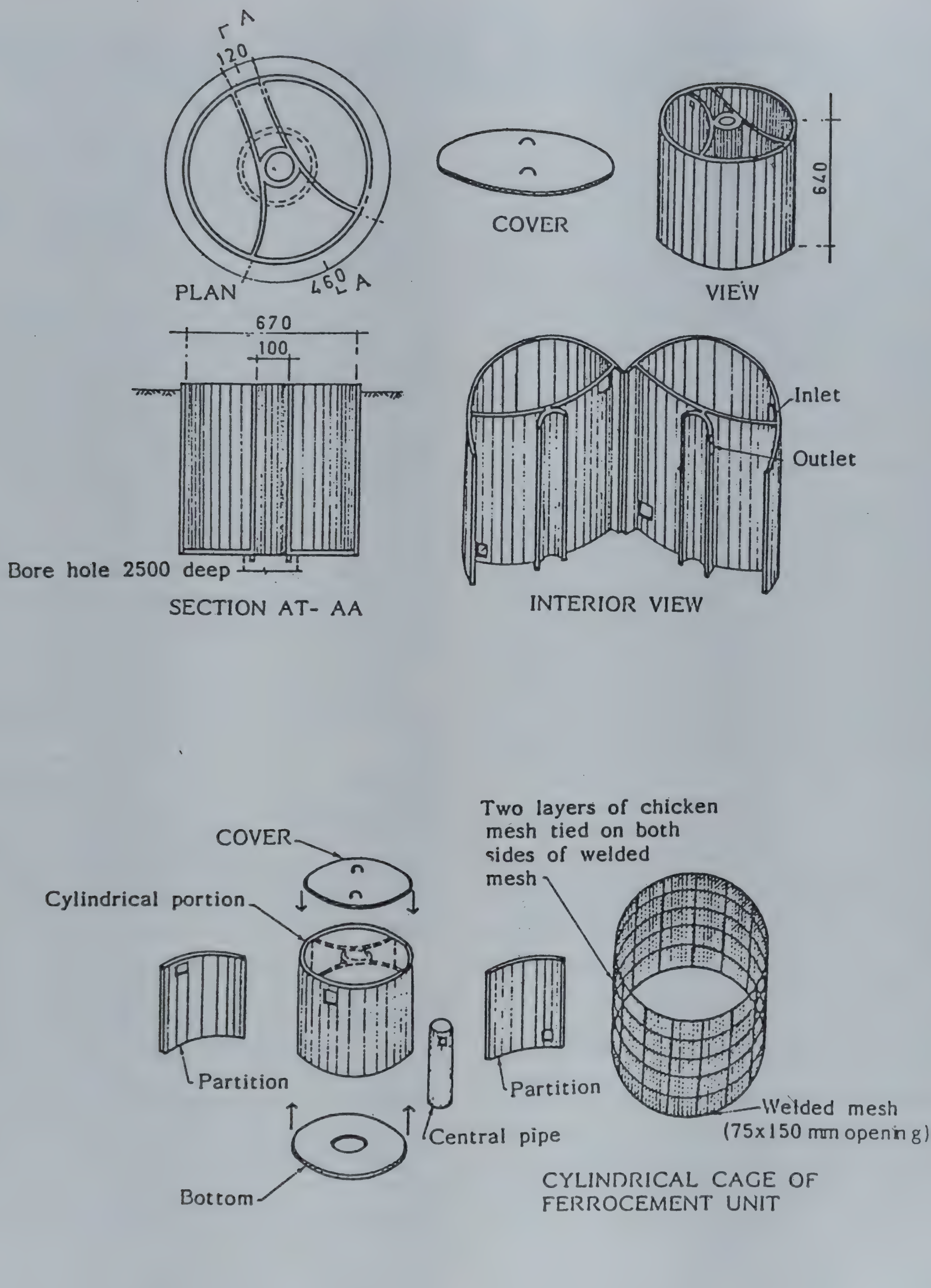


Fig- 8.19 : Precast Ferro-Cement Unit

SECTION-5
MALARIA AND MOSQUITOGENIC PROBLEMS IN ROAD AND RAILWAY TRACKS AND OTHER CONSTRUCTIONS WITHIN URBAN AREA

ROADWAYS

One of the major developmental activity under the national and State Governments' five year and annual plan is the development of rapid transportation systems, viz Road and Railways. The major works of constructing National Highways connecting all States capitals with the National Capital and the important port cities and towns are almost completed under the past seven five year plans and similar network in States, districts and villages is envisaged.

Malaria and Mosquitogenic Problems

In all these cases of alignment of new roadways, widening and improvement of existing roadways, the highway engineers are likely to create malaria and mosquitogenic problems, if they do not have the knowledge of 'man made malaria' and the permanent engineering measures to solve such problems likely to be created by these developmental activities. The alignment of a new section of roadways may follow the existing gradient or it may cut across the natural gradient. In the former case, where a new alignment is proposed to the existing gradient, obstruction to run-off water caused by rainfall over the catchment is minimum, provided the same gradient is followed. More often, the natural gradient is found too steep and hence flatter slopes have to be adopted for roadways, which means raising and embankments as shown in Fig- 8.20. In the latter case, alignment cutting across a natural flow causing a complete obstruction (as shown in Fig- 8.21) to natural flow of run-off water due to rainfall in the catchment. The surface water spreads over wider area with reduced velocity promoting mosquito breeding. It is possible to balance cutting and embankment so that no borrow pits are formed as shown in Fig- 8.22. On the other hand if the cutting is less than the embankment and the earth has to be borrowed from elsewhere, surface scrapping from nearby slopes will not obstruct storm water to flow down the slope as shown in Fig- 8.23. The 'borrow pits' are among the most likely spots for the mosquito breeding. Earth for the construction of embankments for roadways (also for railways) should be borrowed from places where the resulting excavation will not create mosquito breeding sites, if the new alignment is passing parallel to natural steep slope.

While laying a new roadway in flat terrains, the earth for embankment has to be obtained from far-off sloping terrain or borrow pits in the vicinity. Carting of earth beyond a certain limit of load and lift will be uneconomical and retards the progress of work. There will be no other choice left than resorting to borrow pits.

Construction of Borrow Pits

Borrow pits should be of a regular shape and if possible of equal size. Borrow pits should not be continuous but broken into about one metre length.

None should be dug until all cutting has been finished and soil used up in banks and other sources of material have also been exhausted. They should be located along the natural gradient. They should be laid in series so that they can be inter-connected leading the water collection to the lowest level pit which is sized to hold the flow from all pits above. This is a 'lido' - formation.

Depth of borrow pits should not intercept ground water table and bottom of pit should be at least 0.3 m above ground water table. The sides of pit should be sloped so that it becomes stable by its own angle of repose and does not collapse due to saturation of top soil during rainy season. The water collected in the lowest pit should be drained to the valley by a drainage system. Depth should not be more than 0.6 m. Deeper depths involve difficulty in draining to valley or may have to be pumped which is not recommended as it involves energy supply and recurring cost. They should be located at least 1.6 km away from the nearest village or town (Fig- 8.24).

Hill Roads

In the alignment of hill roads in Ghat sections many a time, the road is laid across the natural gradient. Adequate number of water ways to be provided underneath the embankments for an effective cross drainage.

STREAM TRAINING AND CHANNELISATION

The purpose of stream training is to induce the fastest possible flow in the stream or river. This measure could be adopted in the relatively small streams which have a sluggish and intermittent flow and irregular cross section. Stream training consists of increasing embankments slopes to reduce area on side flanks exposed for water collection between H.W.L. and L.W.L. improving longitudinal grade, by removing such impediment as fish raps, boulders from the water course, rebuilding cattle crossings, straightening streams and reshaping banks, besides dredging a shallow channel down the centre of the stream bed. This will either cause complete drying up of many kilometres of sluggish or stagnant pools or restrict the water to a narrow central channel which could be effectively treated with suitable control methods.

River Embankments

River embankments across perennial and non-perennial rivers should have adequate waterways under bridges and culverts to permit flood flows and dry weather flow from the catchment areas as well as the storm water flows from the towns and cities on the banks down the river without causing any water logging or backwater ponds and marginal pockets. Perpetual water collection by such stagnant pools of water along a road or rail track will ultimately lead to raising of subsoil water level, leading to rupture of road surfaces, rail tracks frequently, and thereby increasing the maintenance cost of such roadways and railway tracks.

RAILWAY TRACKS

Malaria and mosquitogenic problems arising out of construction of embankments laying for railway tracks in the vicinity of habitats are similar to what has been discussed under the alignment of roadways. In fact more mosquitogenic and malarious conditions will be created by rail tracks because the rail tracks need to be laid on much flatter slopes and easier curves than roadways, which require more length of embankments which are often laid across the natural slopes, rivers and valleys. All these precautions as described in earlier paragraphs should be necessarily exercised to eliminate barriers across water course and natural overground flow so that water pools are not formed in the vicinity of towns and villages.

Besides extensive use of water in station and yards, the passenger trains discharge considerable amount of waste water (sewage and sullage) on tracks at the stations. Any spent water which is not discharged into a sewage system or rain water does not easily drain away through the yards because of the obstruction caused by tracks laid across the network of open drains. Often the drains passing underneath rail tracks and other control and signalling equipments are chocked which is seldom noticed. This solid waste is washed into the drainage system during monsoon showers causing chocking of drains. Mosquito breeding takes place in these drains. The sullage/ sewage flowing out of the railway colonies are obstructed by the track bund forming cess pools.

The Management should take the following steps:-

1. Regular inspection of all open and underground drains and cleaning them to prevent any obstruction to free flow of waste water.

2. Steps to repair broken drains, sewer lines without delay.

3. Periodic checking of waste water treatment facility (septic tanks, or soak pits of biological treatment units) for their proper functioning.

4. Providing adequate sanitation staff to clean the platform to remove garbage from tracks and to carry out larviciding regularly.

5. Prevent leakage of water from water tendering goose-neck valves, pipes, and stop-cocks supplying water for various purposes and take immediate steps to repair and renewal.

6. Training of sanitation staff in malaria control.

7. Provide suitable drainage system and treatment facility to labour colonies to eliminate cesspools near the tracks.

8. Prevent water collection in valve-chambers and cisterns.

9. Fill up all small and big depressions in the whole area to prevent water pool formation.

10. Discard all empty containers in the yards in such a manner not to collect water during rains.

The usual solution to these situations are same as described in section on water supply and waste water disposal.

PROBLEM OF BRICK KILNS AND STONE QUARRIES

Brick Kilns

Where soil is suitable for manufacture of bricks, fallow lands are leased out to brick manufacturers. With the rapid growth of urban centres, and demand for bricks being far greater than the supply, today any land owner on the outskirts of the city, finds it much more profitable to make use of the soil for brick manufacture than cultivation. The earth is dug to depths, which lowers the level of the piece of ground 4 - 6 m below the level of the surrounding area, with the result that the depression created forms a cup shaped structure, leading to water logging. The water logging, remains almost throughout the year coinciding with malaria season of the area. Mosquito breeding continues throughout the season. The abandoned brick field becomes a small pond or lake.

Methods for prevention and control of mosquitogenic conditions in brick fields:-

1. All brick manufacturing factories should be governed by the Water and Air Pollution Control Act and be licensed before setting up the factory.

2. The site for brick fields should be at least 3 km away from the nearest dwelling in the area.

3. The land should be slopping and with natural drainage towards a nearby valley section.

4. A control plan and block level plan of the site with 0.3 m contour should be prepared up to valley section.

5. With the help of the contour plan/block level plans, maximum depth of cutting at different points can be chosen, so that after digging the whole area, the land is still gently slopping towards the valley.

6. Land cutting should start from the valley so that the natural drainage is not interrupted and no depressions are created to form water pools.

7. The present practice of digging a kutcha cistern in the land itself to collect rain water during the rainy season (needed for brick moulding) should be abandoned. Instead, a pucca masonry tank should be built with a drainage system, during mosquito breeding season, water level may be lowered by a few inches every week, thus flushing the mosquito larvae, eggs, and pupae and stranding them on ground.

8. Where land is flat and cannot be drained, filling the depressions created by making use of dismantled construction materials, excess earth available in construction works going in the city, cinder & ash, saw dust, garbage, etc.

9. Where small streams are available at a higher elevation, the brick pits can be silted up by diversion of stream laden with silt.

10. Filling depressions, and levelling the surface so that no rain pools form is the key to the success of preventing mosquito breeding in the brick fields during and after brick making operation.

Stone Quarries

Stone quarries present similar malaria and mosquitogenic problems as discussed under brick kilns. All mechanised operations lead to atmospheric pollution and hence the industry should come under the preview of Water and Air Pollution Control Act.

Methods of Prevention and Control of Mosquitogenic conditions in Stone Quarries

1. All Quarries should be governed by the Water and Air Pollution Control Act and be licensed under the small scale industry.

2. The site should be at least 3 km away from the nearest structure/building in the area.

3. Sound methods of quarrying by blasting should be adopted so as not to produce a deep crater and also do not produce a wavy surface configuration forming small depressions (Fig-8.25).

4. Only rock outcrop should be quarried and quarrying below the general ground level surrounding the rock should not be allowed.

FACTORIES MANUFACTURING CONCRETE STRUCTURAL ELEMENTS

There are many small industrial units manufacturing building components such as RCC slabs, window frames, RCC pipes, RCC poles for transmission lines, flower pots, etc. They should be located at least 3 km away from the town. If they cannot be shifted outside the town, the curing tanks built in these factories should be drained every week.

MOATS AROUND ZOOS, PICNIC SPOTS AND HISTORICAL BUILDINGS

These are highly mosquitogenic. Examples are moat around Delhi Red Fort, moat in Delhi Zoo, water channels in Rajghat area, etc. The historic moats are quite wide and deep as they were meant to prevent access of enemies into the fort. They are filled up by rain water and drainage from the town inside the fort. They are of irregular shape and overgrown with weeds. The best solution to prevent mosquito breeding in these moats is to fill them up with city solid through controlled tipping taking care to ensure that empty containers are crushed before burial. Where moats are to be retained as a part of monument preservation, they should be cleared of all vegetation and lined to maintain water clean, without any marginal vegetation.

The city drainage and sewage should not be discharged into the moats. In other types of moats like the one around zoos and picnic spots, continuous flow of water by recirculation should be maintained with a mean velocity of flow not less than 0.6 m/sec at the margin which prevents mosquito breeding. However, antilarval measures should be an additional precaution.

Metro Railway

The first Metro Railway construction was undertaken in Calcutta. Deep trenches were dug below water table by mechanical excavators and the earth excavated was dumped indiscriminately on both sides of excavation on the main arterial road like Chittaranjan Avenue, Russa Road, Tollyganj main road, etc. This resulted in obstruction in drainage of storm water into the city underground combined sewerage system. The result was formation of stagnant pools of water on the road surfaces and side pavements and in low-lying areas. Since construction work lasted for several years, it increased the mosquito breeding areas and the consequent malaria problem. The lesson learnt in this construction should be utilised to prevent creation of malaria and mosquitogenic conditions in any future metro construction work. In order to avoid obstruction to free flow of storm water on the roadways and pavements during metro constructions and construction planning should be done in consultation with public health authority of the city and State. Temporary measures to drain the surface run-off should be taken during the construction stage.

The suitable method is dewatering of seepage water inside duct with suitable capacity pumps and alternate power supply and leading off the seepage water to well maintained surface or underground drainage system discharging it into river at suitable points. All pipeline carrying water or waste water laid underground in the vicinity of metroduct should be kept in good condition so that no leakage into metroduct takes place and periodic leak detection survey of all pressure pipelines should be carried out to ensure this.

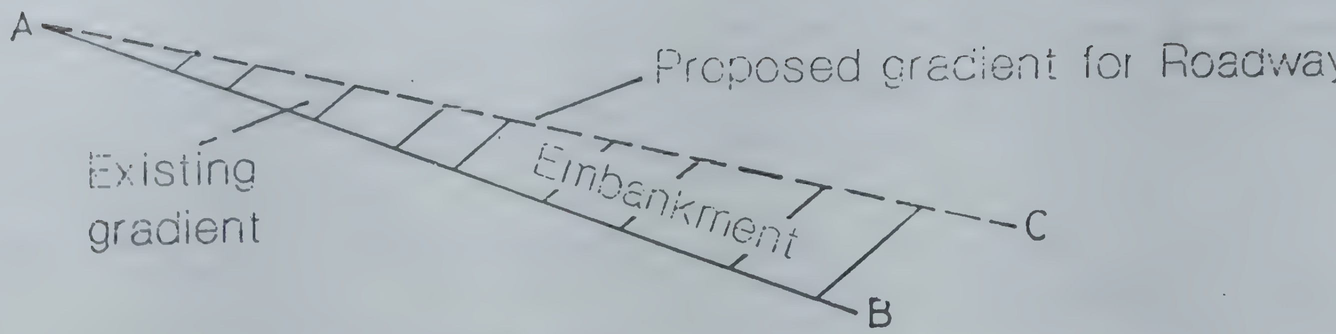


Fig- 8.20 : Road along Natural Gradient with Reduced Slope

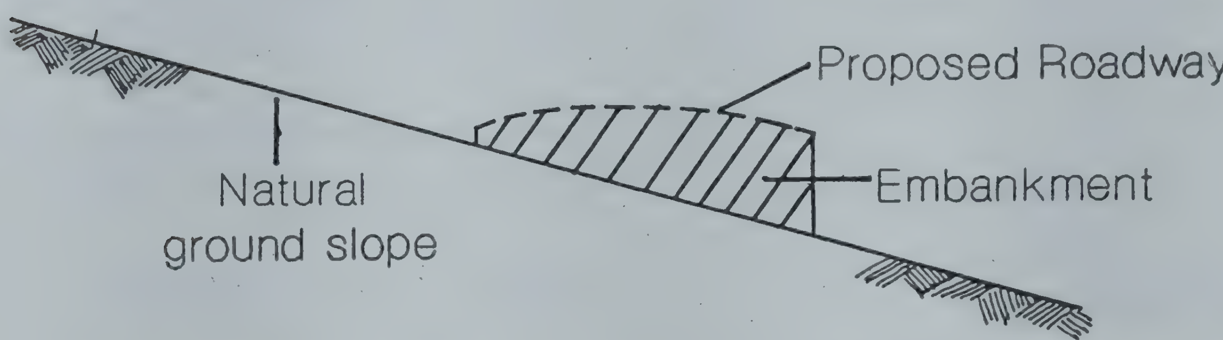


Fig- 8.21 : Road along Natural Gradient with Reduced Slope

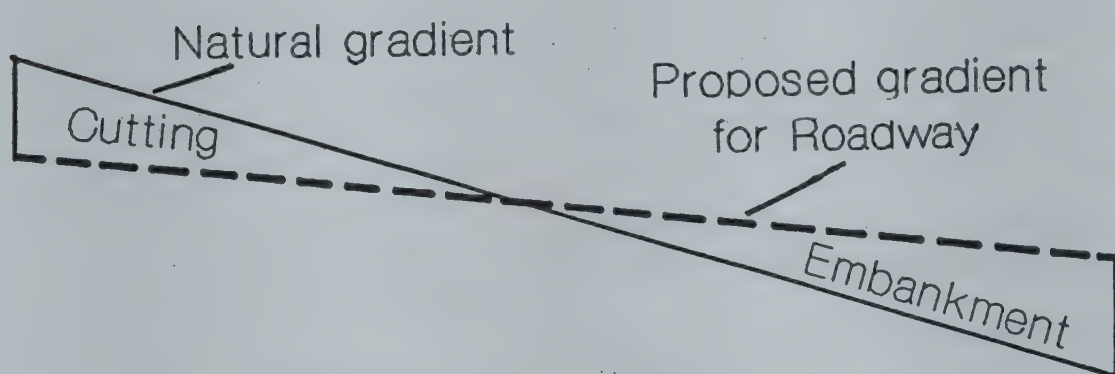


Fig- 8.22 : Balancing Cutting and Embankment

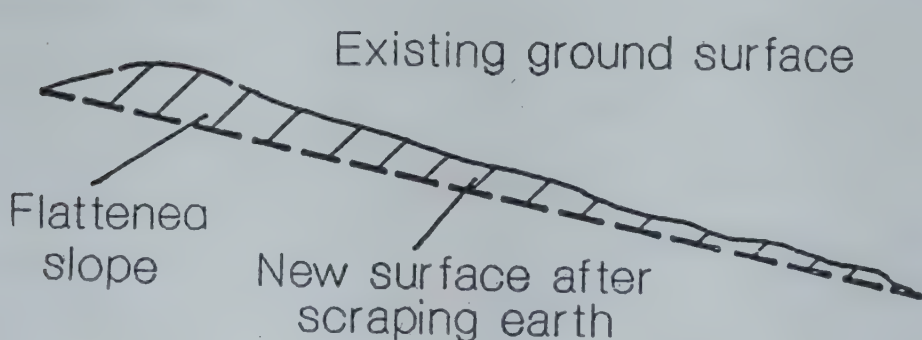


Fig- 8.23 : Surface Scrapping from Marshy Slopping Ground

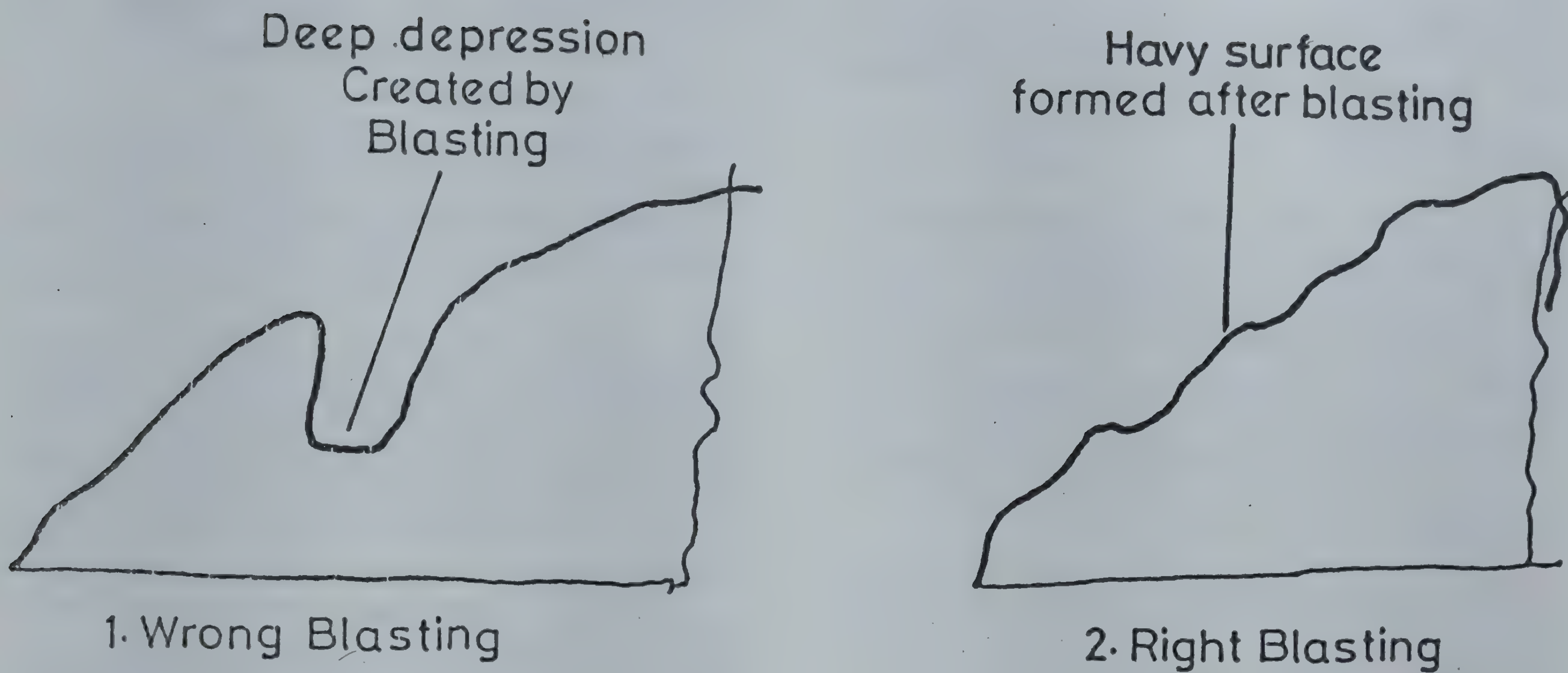


Fig- 8.24 : Laying of Borrow Pits to form a Lido System

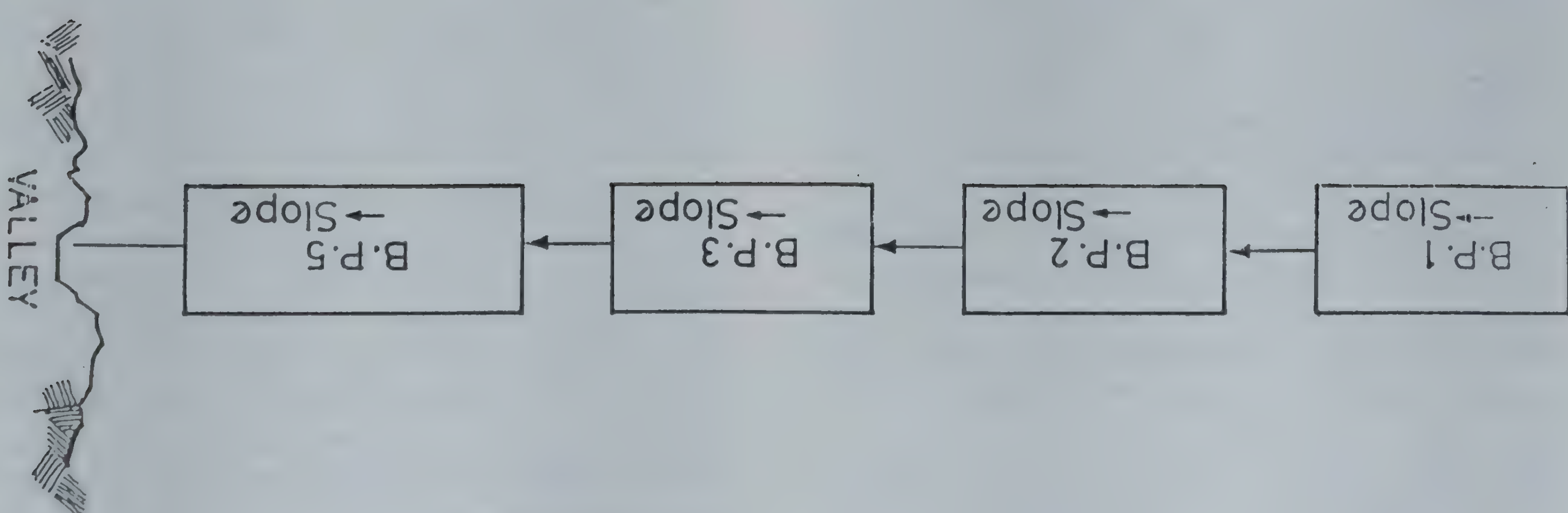


Fig- 8.25 : Blasting

SECTION-6
WATER RESOURCES DEVELOPMENT PROJECTS AND THEIR MANAGEMENT IN RELATION TO VECTOR BREEDING

INTRODUCTION

To accelerate the pace of socio-economic development, most of the countries, especially developing countries continue to plan and execute water resources development schemes in large numbers. Though there are positive consequences of these projects such as irrigation, water storage, power generation, etc. these are responsible for many adverse effects usually on health and environment.

With regard to health, the National Water Policy (1987) states 'project planning for development of water resources should as far as possible, be for multiple benefits based on integrated and multi-disciplinary approach having regard to human and ecological aspects and special needs of disadvantaged sections of the society. Maintenance, modernisation and safety of structures should be ensured through proper organisational arrangements'. In practice health aspects of water resources development projects (WRDPs) are completely ignored. At present all major projects need clearance from the Department of Environment which unfortunately does not examine projects from the vector breeding view point. The Planning Commission (1985) has stated in the 7th five year plan document that existing irrigated areas where salinity and water logged areas have been identified, adequate drainage facilities would be provided and it has become an important part of irrigation projects. It would be ensured that new project estimates would include necessary drainage arrangements. Lining of canal system either wholly or partially has been accepted as a necessary investment and it is being taken up on priority basis. The importance of this approach has been accepted by the States. In Punjab, Haryana and a few other States, lining of substantial stretches of canal has already been completed. It may be mentioned that lining of canals is being done to prevent water loss and not for any health consideration, such as the prevention of mosquito breeding. In fact there is no awareness of this aspect of environmental degradation among the canal and its tributaries provide ideal breeding places for mosquitoes. To irrigate command areas, water in the canal is released on rotation basis. This policy has been adopted on the recommendation of the World Bank for equitable distribution of water. Water is released at 4 to 6 weeks interval. During the period when regular flow in the canal is closed, a thin sheet of standing water supports heavy mosquito breeding. It becomes an ideal site for proliferation of *An.culicifacies,* the control of which is most difficult. A weekly release of water would ensure control of mosquito breeding by flushing effect but this is never done.

It is notable to mention that the scheme on Sarda Canal Project (Banbasa, U.P.) was sanctioned in 1913 to irrigate 12 famine prone districts of Oudh. The work could not be taken up immediately due to World War I and also the fact that the requirement of the number of the drainage cuts (cross drains) to prevent water logging in the command area could not be ascertained. This was considered essential because following the opening of Ganga Canal in 1854 there was a rise in sub-soil water and the water logging resulted in an increased incidence of malaria. It is noteworthy to mention that drainage in command area was ensured, before the opening of Sarda Canal in 1929. Malaria Control by spraying residual insecticides changed the outlook of planners and this aspect of drainage did not receive adequate attention. Jayaraman (1982) clearly brings out the importance of drainage from the command area of Mahi-Kadana project in Kheda, Gujarat. In this area, year round irrigation and multiple cropping of paddy has resulted in an increase of malaria over a period of 18 years. The situation is worsened by over-irrigation and poor drainage.

Alteration in ecosystem

Water table beyond and below the reservoir or

due to seepage influences the adjacent territory and alter local climate, soil and vegetation, local fauna including micro-organisms.

There is evidence that community health is undermined by the projects due to the spread of waterborne and vector borne diseases. Water resource development projects have altered the capacity to assimilate pollution load would also be altered.

There is evidence that community health is undermined by projects due to the spread of water borne and vector borne diseases. Water resource development projects have altered significantly the distribution of vectors in some regions.

LACK OF AWARENESS OF PROJECT PLANNERS ABOUT HEALTH ASPECTS

The attention of water resource development management is focussed primarily on the water resource management *vis-a-vis* economic benefits only. Project plan group is usually not aware of health problems that are likely to crop up in the project area and hence needs study on community. A proper understanding of the environmental and health impacts would result in optimal water resource management which will ensure minimal effect on health and environment thereby adding to national productivity and economy.

HEALTH RISKS SPECIFIC TO WATER RESOURCES PROJECTS

The entire health risks can emanate:-

a. Indirectly, or

b. Directly from the water resource projects.

The changes in human populations start from the time when the land is acquired, local population is rehabilitated in other areas, followed by congregation of imported labour of heterogeneous health status at the construction site which may continue for decades. During this period new groups come and go constantly keeping the human population in a flux. These groups are usually housed in temporary dwellings without proper sanitary conditions and water supply. In the final stages colonies for project maintenance, industries and ancillary townships are built in the vicinity of reservoir area. During construction phase or for permanent settlement if adequate precautions are not made the vector borne disease epidemiology may show sudden or long lasting change.

Great care should be taken even during planning and execution of project to cater to the health needs of different population groups. Such measures should be in consonance with the cultural belief of the population groups. Children and pregnant women are particularly exposed to the disease risk during the period.

The increase in the density of human population or the invasion of sylvatic ecosystems has exacerbated the transmission of a number of diseases.

An adequate foresight and creation of physical facilities and reinforcement or creation of a proper health infrastructure would sort out health problems. These usually should form an integral component of the plan.

The health problems associated with the water resource project centre are mostly on account of the vector borne diseases which are directly linked with such water projects.

Vector borne disease implications in water resources projects

By far the most important family of insect vectors are mosquitoes. Particularly in India mosquitogenic problems are the gravest health concern in relation to water resource development projects. Such problems in various possible components of water resource development and their solutions are discussed here.

VECTOR PROBLEMS IN RIVERS AND CANALS AND THEIR SOLUTION

This subject has been dealt in Section-2. However important points are again brought out here.

Rivers and Streams : Usually the natural rivers and canals have constantly flowing water and as such except in water where the speed of the flowing water is less than 0.6 m/sec along the banks the chances of mosquito breeding would be

remote. However, stream water breeders like *An.fluviatilis* may still breed in streams. Sluicing and flushing would be the solution for such problems. The method has been found to be very effective for *An.minimus* and *An.maculatus* control. The flushing need not be automatic, but experience has favoured the self terminating siphon structure.

Bank protection by construction of levees will not only prevent formation of swamps, backwater pools and marginal pockets but also give flood protection.

Similarly deepening of a central channel, diversion of peak flow through flood ways, channel straightening, etc. which are means for general river management, would minimise mosquito problems (Fig- 8.26).

Canals

Mosquito breeding is associated with poor canal conditions in general. Where the water flow is sluggish, or canal banks are eroded or choked with vegetation, or where channel sections are irregular, or where seepage pools along canals have been generated, mosquito breeding is a real danger. Such situations can be controlled by the following strategies.

a. Lining of the canal

b. Good alignment of the canals and avoidance of sharp bends/curves.

c. Effective canal maintenance to ensure that the canals are in good shape and generally free from vegetation and silting at all times.

d. Canal flushing.

Where suitable earth material is available near the site of construction it may sometimes be economically used for lining but the efficiency of such lining in respect of mosquito control from all aspects is inferior.

Breeding site preference depends *inter-alia*, on the exact degree of shading, water flow rate and amount of organic pollution.

Likely breeding places created by a water resource development project

Impoundments - Large bodies of stagnant fresh water are exposed to full or partial sunlight. Larvae occur near floating or emergent vegetation or foliage near the edges. They include lakes, pools, bays, large borrow pits, slow rivers and pools in drying beds of rivers and major streams.

Marshes - Marshes, bogs and swamps due to soil saturation on account of impoundments.

Rainpools - Small collection of stagnant water often muddy, but not polluted, exposed to full or partial sunlight, the vegetation may be present or absent. These include roadside ditches, clogged drainage ditches, small borrow pits, wheel ruts, hoofprints, natural depressions, puddles and any other low lying land.

Rice Fields - Seasonal breeding sites especially important between transplanting and closure of canopy.

Shaded Water Partially or heavily shaded water in forest includes pools, ponds, swamps and sluggish streams.

Streams - Running water courses, clear fresh water exposed to direct sunlight, includes lowland grassy or weedy streams and irrigation channels.

Seepage - Springs, seepage from dams, irrigation channels usually clear water exposed to direct sunlight.

Natural Containers - Plant hollows and cavities etc.

Artificial Containers - Wells, cisterns, water storage tanks, ornamental basins, tins, plastic packages, abandoned car tyres.

Polluted Water - Heavily contaminated water organic waste exposed to direct sunlight. Usually in or near human settlement areas.

Other Breeding Sites - Many other categories could be identified according to local circumstances.

CLASSIFICATION OF THE EFFECTS OF HUMAN ACTIVITY ON THE ENVIRONMENT IN RELATION TO VECTOR SITES

1. Water Surface - The water surface area increases through the construction of

impoundments, water courses and ricefields. Inadequate drainage from settlement and fields and seepage from unlined canals lead to the formation of pools and swamps.

2. **Water Table** - Rise in the water table resulting in water oozing from the ground e.g. in diggings, shallow wells such formation leads to permanent pools and contributes to the problem of drainage.

3. **Submergence** - Reservoir of impounded water results in submersion of old river banks and vegetation also changes the shoreline in the area.

4. **Water Course** - Construction activity involving stoppage or diversion of streams, creation of irrigation and drainage channels. The number, size and length of water courses may be altered and the volume and flow rate of water changed. Water courses may be lined or unlined with steep or shallow sides and open or enclosed in pipes. Seepage water from unlined channels may increase stagnant water surface area. The banks of water course may be affected by increased seepage and pool formation.

5. **Movement** - People, animals and heavy equipment moving into and through the project area. Construction of roads, paths and fords, formation of depressions which collect rain or ground water, deform banks of water courses and margins of reservoirs by trampling.

6. **Settlement** - Construction and use of temporary housing with inadequate water supplies, water storage and sanitation facilities.

7. **Excavation and Cultivation** - Construction of roads, clearance of trees and other vegetation, excavation leads to formation of ditches and borrow pits. Cultivation practices involving rigging, banking or flooding cause temporary increase in water surface area.

8. **Aquatic Succession** - Development activities create new aquatic habitats which are colonised by a variety of plants and animals. The plants will affect the flow of water along the impounded margins. Both seasonal and longer term succession may occur and recur following further disturbances.

9. **Terrestrial Succession** - Newly cleared land recolonised by plants and animals including grasses and shrubs and later thickets and trees. Seasonal and long term successions occur and are disrupted by activities such as grass burning.

10. **Organic Pollution** - Passive or active contamination of water with domestic and agricultural waste, especially around human settlements due to inadequate or poorly maintained waste disposal system generates conditions suitable to vector breeding and disease transmission.

11. **Inorganic Pollutions** - Contamination by waste products of construction such as cement, engine oil, silt and agricultural chemicals is detrimental to both vectors and their natural enemies and also leads to environmental degradation.

12. **Landfill** - Raising the level of the low lying land for construction may cover surface water and reduce breeding sites. The soil must be excavated from somewhere also so that new excavated depressions/borrow pits are not created which form very good breeding sites for mosquitoes.

Curves in Canals

Canal with bad alignments rapidly deteriorates through erosion and silting. Canals should, therefore, have long straight reaches or large radial curves as far as possible.

The flushing of canal is similar to that in streams which has already been discussed.

MOSQUITO PROBLEMS IN IMPOUNDED RESERVOIRS OR LAKES AND THEIR SOLUTIONS

Impounding reservoirs are built on upland streams for the purpose of storing precipitation from catchment area for use during the period when the natural flow of river/stream is insufficient to maintain a safe yield. The water level variations in the reservoir can be quite wide (up to 3 m or more) during a normal year and may be considerably more during drought. Since the water quality is of prime importance, the pre-impoundment reservoir preparation is mandatory.

It has been observed that in the absence of floating mat of vegetation, mosquitoes do not breed in deep water far from the reservoir margins. Nor there is any significant mosquito breeding along the steep main shoreline exposed to wave wash. The protected bights, hollows and indentations of the shoreline are areas subject to mosquito problems. Where water is shallow and filled with aquatic vegetation and floating material where mosquito larvae find food, necessary protection from currents, wave action and wind cover from natural enemies can be obtained.

RESERVOIR DESIGN AND CONSTRUCTION - CONSIDERATIONS FOR MOSQUITO CONTROL

For mosquito control the following items of works should be given special consideration and need to be provided for in the budget during the design and subsequent phases of the project.

a. Proper preparation of reservoir site and in particular the clearing of trees and other vegetation to ensure a clean water surface at all elevations between high and low operating water levels.

b. The necessary provision for fluctuating the water level whenever necessary.

c. Suitable marginal drainage to avoid isolated pools along the reservoir margins when the water level fluctuates.

d. Permanent works, where economically feasible to eliminate vast shallow areas on the margins of reservoir close to human habitation.

e. An effective programme for shoreline and drainage maintenance, vegetation growth control and drift water removal after the reservoir has been filled.

Environmental Modification Measures

These measures are mostly directed to the preparation of reservoir sites, shortening and implementation of the reservoir shoreline.

Reservoir Site Clearing

The basin must be altered or otherwise prepared prior to filling so that clean water is available at all elevations of operating zone.

Drainage of Reservoir Margin

Marginal drainage must be provided for the zone between the maximum and minimum water levels of the reservoir.

Deepening and Filling

Where a large population is to be protected, the shallow margins of a reservoir can be made unsuitable for mosquito breeding through topographical alteration which can be accomplished by:-

a. Filling the marginal problem zones to a level above the maximum water level.

b. Deepening the problem zone to a depth below the lower limit of marginal growth invasion **or** a combination of both. The most economical method would be the combination, since excavated earth can be utilised for filling.

Diking and Dewatering

Where deepening and filling would involve major earth-moving operations, it may be necessary to consider the possibility of building dikes or levees to isolate large shallow bays for reclamation by dewatering. Such areas, if remaining inundated could provide numerous mosquito breeding places which would be extremely difficult to control. Diking and dewatering were used extensively in Kentucky reservoir for mosquito control by the Tennessee Valley Authority (TVA).

Environmental Manipulation Methods

Water Level Management

The major strategy of malaria mosquito control following impoundment is the water level management. It involves shoreline maintenance, shading by tree planting, artificial flooding and drift removal.

SUMMARY OF ENVIRONMENTAL MANAGEMENT

Canal Design:

1. Straight canals to eliminate standing pools.

2. Mechanical screening of water intake against snails.

3. Bridged crossing points.

4. Built-in chemical dispensers at strategic points.

5. Vegetation clearance.

6. Seepage control.

Reservoir Design:

1. Minimum high storage reservoirs.
2. Periodic drawdown.
3. Vegetation clearance.
4. Spillways.
5. Inundation of breeding sites.
6. Steep, regular banks.

Irrigation and Drainage Design:

1. Increase water velocity, but prevent scouring.
2. Desilting and vegetation clearance to prevent slow water flow and remove food for snails.
3. Proper field drainage.
4. Lining major water contact points.
5. Sprinkler irrigation if feasible.
6. Filling surface water collections.
7. Intermittent irrigation.

Settlement Design:

1. Properly sited villages.
2. Piped water supplies.
3. Properly designed and located latrines to ensure effective use and to prevent sewage entering water system.
4. Fencing and zoning.
5. Children swimming pools and other recreation sites.
6. Community laundries.
7. Waste disposal.
8. Home construction materials and design.
9. Pathways and bridges.
10. Domestic animal pens.

Earthworks:

Diking, drainage, grading and infilling.

CONCLUSION

A true appreciation of the influence of water resource development projects on health risks requires a specific survey including pre and post-impoundment data.

In general, health risks are greater in highly endemic areas of disease with economically weak population groups. Organisational, budgetary resources for an appraisal of the future risks, an early preventive intervention is not expected in project of medium or small capacity. In countries or regions without adequate infrastructure for the control of health risks. These lapses may in turn severely damage the local population. The development of preventive programmes are, therefore, urgently needed to support maintenance around these constructions.

Lack of proper coordination of administrative bureaucracies and international separation usually result in water impoundment schemes being implemented by relatively meagre capital resulting in increased disease prevalence and later the cost of managing these disease outbreaks is transferred to under-financed or weaker health care services. Full policy recognition of the essential complementary of economic development and health would afford the opportunity for coordinated planning for prevention or minimisation of health hazards emerging from water impoundment schemes. This would distribute the benefits and the costs over the nation as a whole. Thus water developmental projects should take place into account health protection through all the stages of planning, design, building and subsequent operation of a project. This would ensure that developmental intervention be evaluated in their ecological entity so as to avoid or minimise the negative consequences to human health. It should be appreciated that continuing transgressions of the essential complementaries of development and health cannot be allowed to go unchallenged.

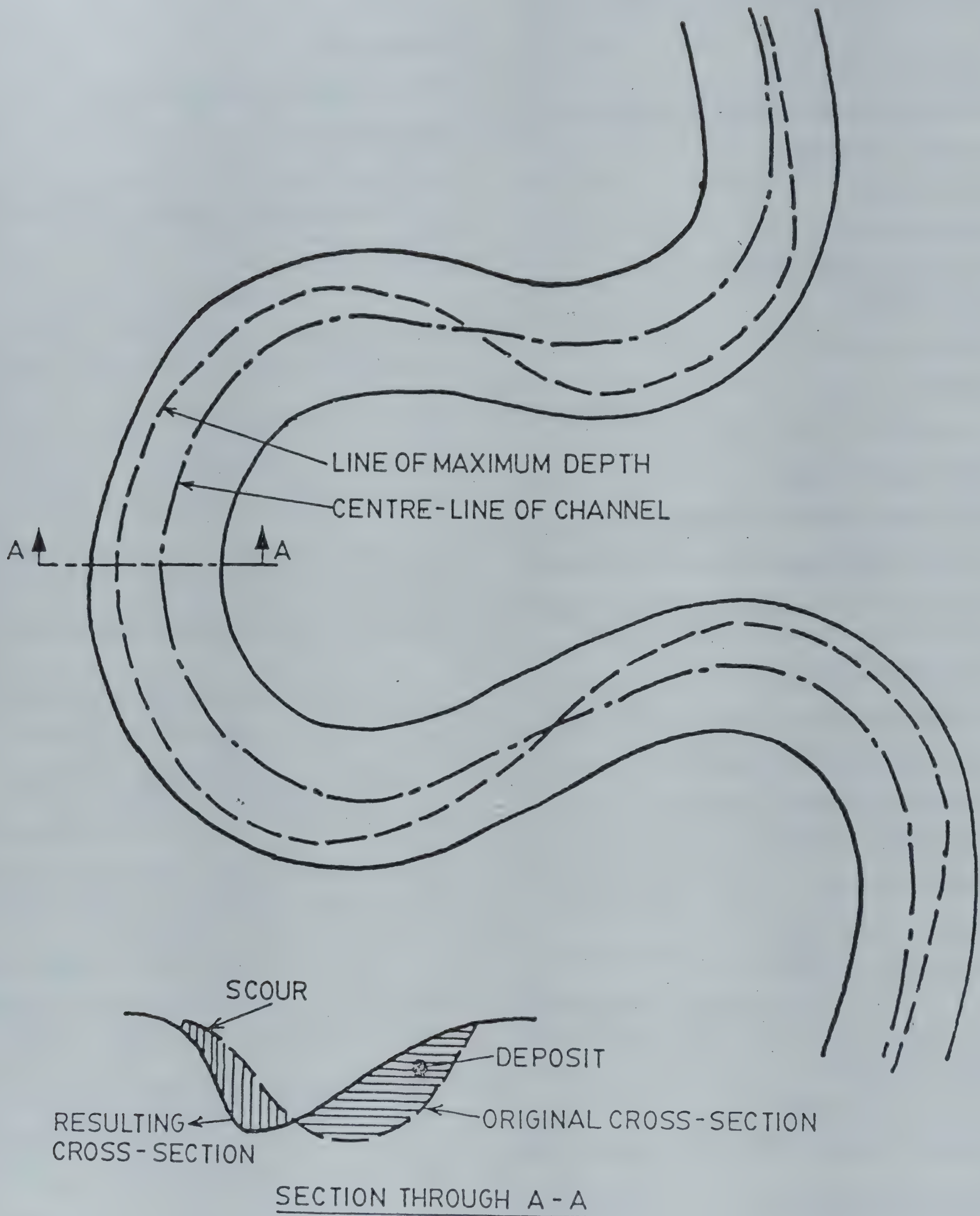


Fig- 8.26 : Distortion of Channel Bed

SECTION -7
MODEL CIVIC BY-LAWS IN URBAN AREAS

For management of domestic and extra-domestic mosquito breeding places, adoption and enforcement of by-laws for use under Urban Malaria Scheme are framed as under:-

Control of malaria and other mosquito borne diseases.

Draft provisions suggested for adoption under appropriate section/rule prevailing in the State.

Application of this Provision

1. The State Govt./local authority constituted under any act may enforce the following provisions to the whole or any part of the State/ local authority area.

2. (1) If the provisions have been extended, no person or local authority shall, after such extension:

(a). have, keep, or maintain within such area any collection of standing or flowing water in which mosquitoes breed or are likely to breed, or

(b). cause, permit, or suffer any water within such area to form a collection in which mosquitoes breed or are likely to breed, unless such collection has been so treated as effectively to prevent such breeding.

(2). The natural presence of mosquito larvae, in any standing or flowing water shall be an evidence that mosquitoes are breeding in such water.

Treatment of Mosquito Breeding Places

3. (1). The Health Officer may, by notice in writing, require the owner or the occupier of any place containing any collection of standing or flowing water in which mosquitoes breed or likely to breed, within such time as may be specified in the notice, not being less than 24 hours, to take such measures with respect to the same, or to treat the same by such physical, chemical or biological method, being measures or a method, as the Health Officer may consider suitable in the circumstances.

(2). If a notice under sub-section (1) is served on the occupier, he shall in the absence of a contract expressed or implied, to the contrary, be entitled to recover from the owner the reasonable expenses incurred by him in taking the measures or adopting the method of treatment, specified in the notice and may deduct the amount of such expenses from the rent which is then or which may thereafter be, due from him to the owner.

Health Officer's Power in Case of Default

4. If the person on whom a notice is served under provision 3 fails or refuses to take the measures, or adopt the method of treatment, specified in such notice within the time specified therein, the Health Officer may himself take such measures or adopt such treatment, specified in such notice within the time specified therein, and recover the cost of doing so from the owner or occupier of the property, as the case may be, in the same manner as if it were a property tax.

Protection of Antimosquito Works

5. Where, with the object of preventing breeding of mosquitoes in any land or building, the Govt. or any local authority or the occupier at the instance of the Govt. or local authority, (have constituted any works) in such land or building, the owner for the time being as well as the occupier for the time such land or building shall prevent its being used in any manner which causes or is likely to cause the deterioration of such works, or which impairs, or is likely to impair the efficiency.

Prohibition of Interference with such Works

6. (1). No person shall, without the consent of the Health Officer, interfere with, injure, destroy, or render useless, any work executed or any material or thing placed in, under or upon any

land or building, by the orders of the Health Officer with the object of preventing the breeding of mosquitoes therein.

(2). If the provisions of sub-section (1) are contravened by any person, the Health Officer may re-execute the work or replace the materials or things, as the case may be, and the cost of doing so shall be recovered from such person in the same manner as if it were a property tax.

Section in respect of household Cans and other Containers

7. The owner or occupier of any house, building, or shed or land shall not therein keep any bottle, can or any other container, broken or unbroken, in such manner that it is likely to collect and retain water which may breed mosquitoes.

8. All borrow pits required to be dug in the course of construction and repair of roads, railways, embankments, etc. shall be so cut as to ensure that water does not remain stagnant in them. Where possible and practicable the borrow pits shall be left clean and sharp edged and extra expenditure not exceeding 1 per cent of the cost of the earth work in any project may be incurred to achieve this. This bed level of borrow pits shall be so graded and profiled that water will drain off by drainage channels connecting one pit with the other till the nearest natural drainage nullah is met with. No person shall create any isolated borrow pit which is likely to cause accumulation of water which may breed mosquitoes.

9. In case of any dispute of difference of opinion in the execution of any antimosquito scheme or in its operation or any work under these provisions in which the jurisdiction of the Govt. of India, or Govt. of any other State is involved, the matter shall be referred to the Govt. of India for final say in the matter.

10. Process of Health Staff to enter and inspect the premises.

For the purpose of enforcing the provisions, the Health Officer or any of his subordinate not below the rank of Health or Sanitary Inspector may, at all reasonable times, after giving such notice in writing as may appear to him reasonable, enter and inspect any land or building within his jurisdiction and the occupier or the owner as the case may be, of such land or building, shall give all facilities necessary for such entry and inspection, and supply all such information as may be required of him for the purpose aforesaid.

Some of the engineering designs for bioenvironmental control of mosquitoes are illustrated in Annexure- 8.1.

Annexure - 8.1

SOME ENGINEERING DESIGNS FOR BIOENVIRONMENTAL CONTROL OF MOSQUITO BREEDING

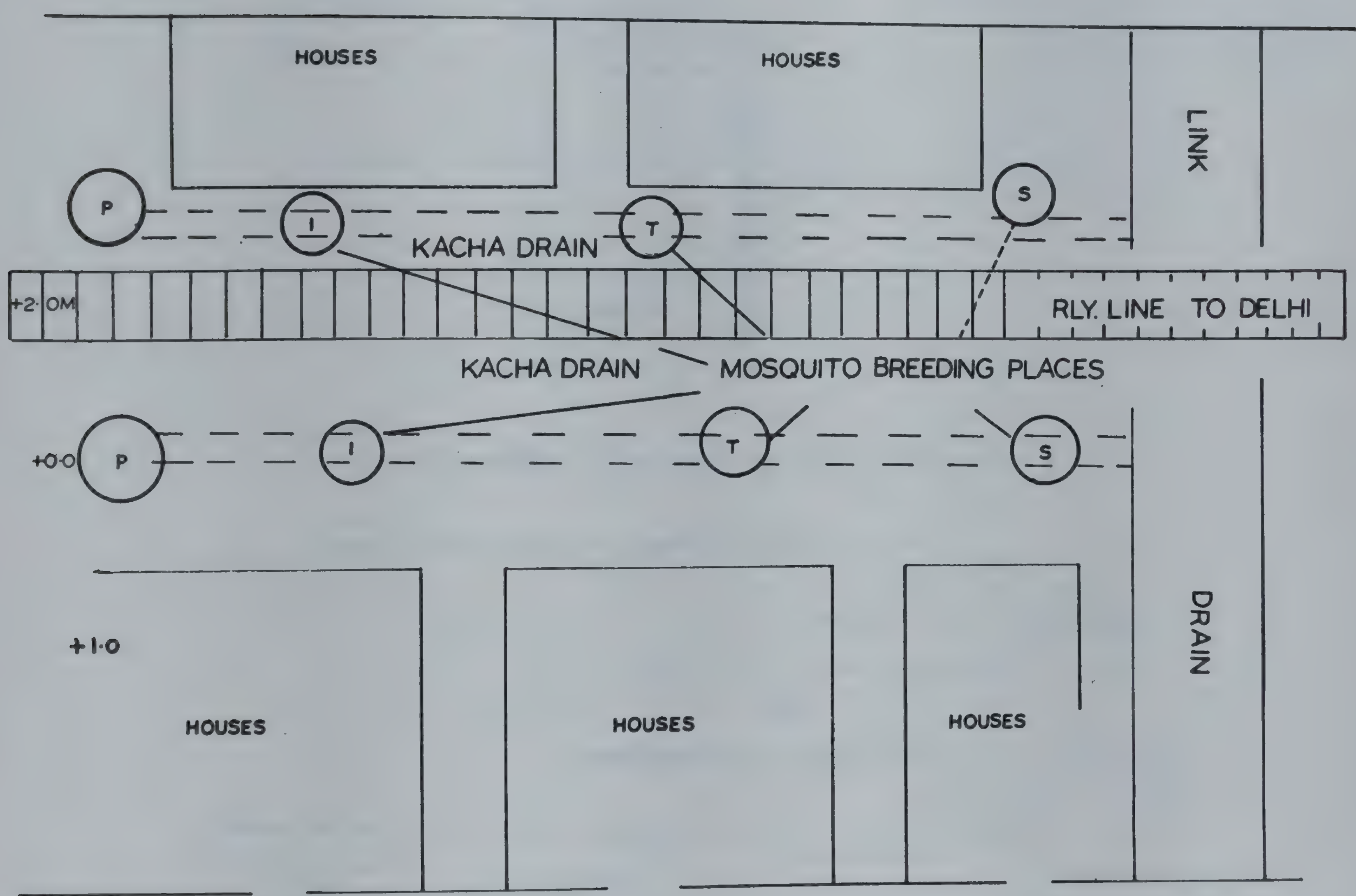


Fig- 8.27 : Mosquito Breeding Places Near a Railway Line

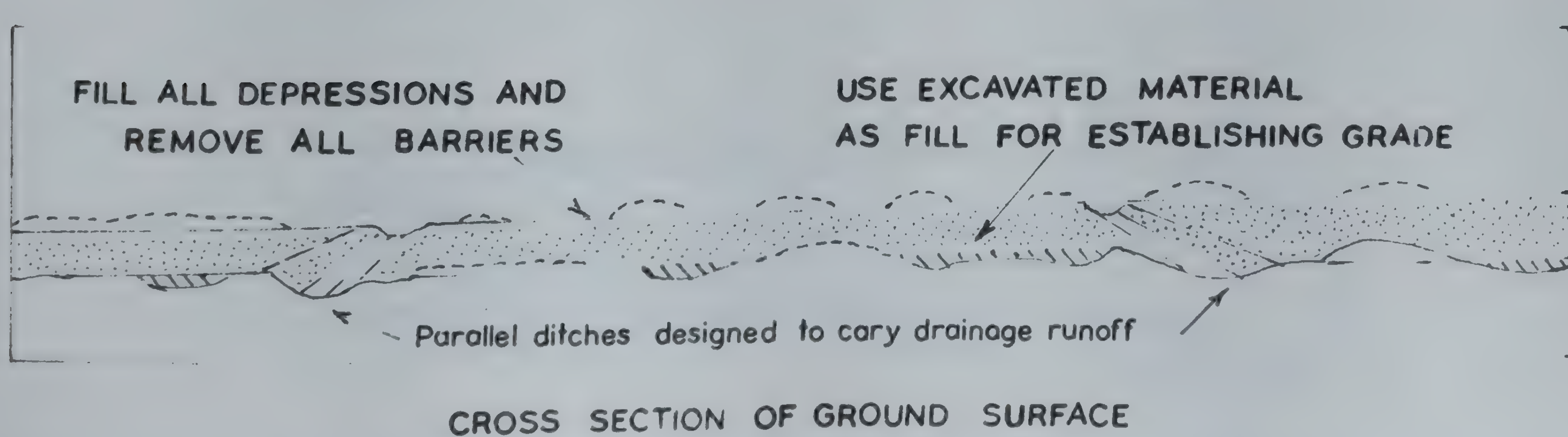


Fig- 8.28 : Technique for Grading Small Depressions and Pockets

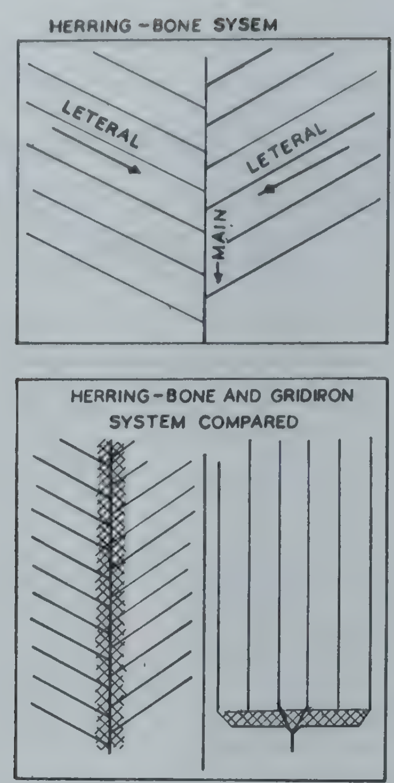


Fig- 8.29 : Surface System for Swampy Area

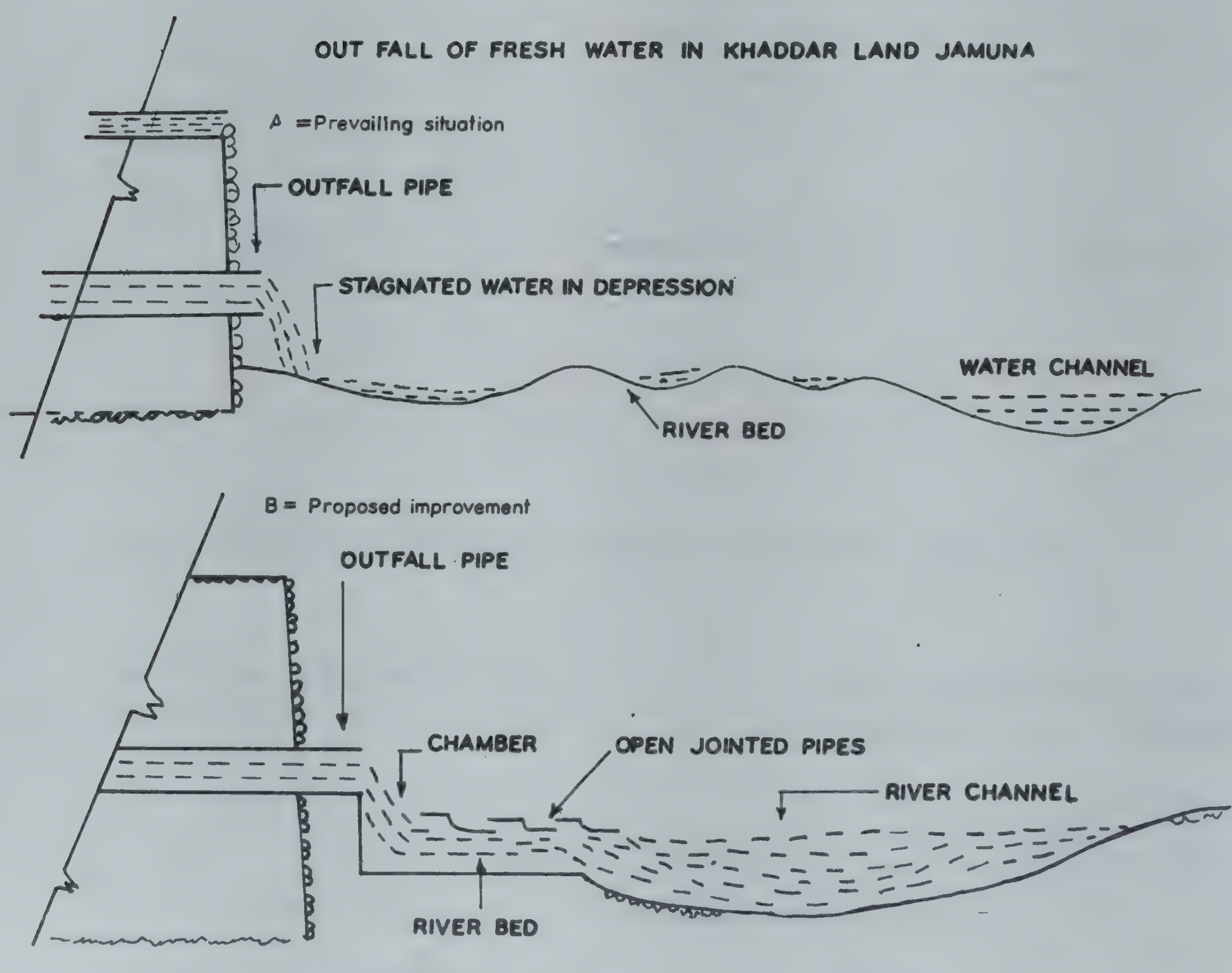


Fig- 8.30 : Prevailing Situation & Proposed Improvement in Khaddar Land of River Yamuna

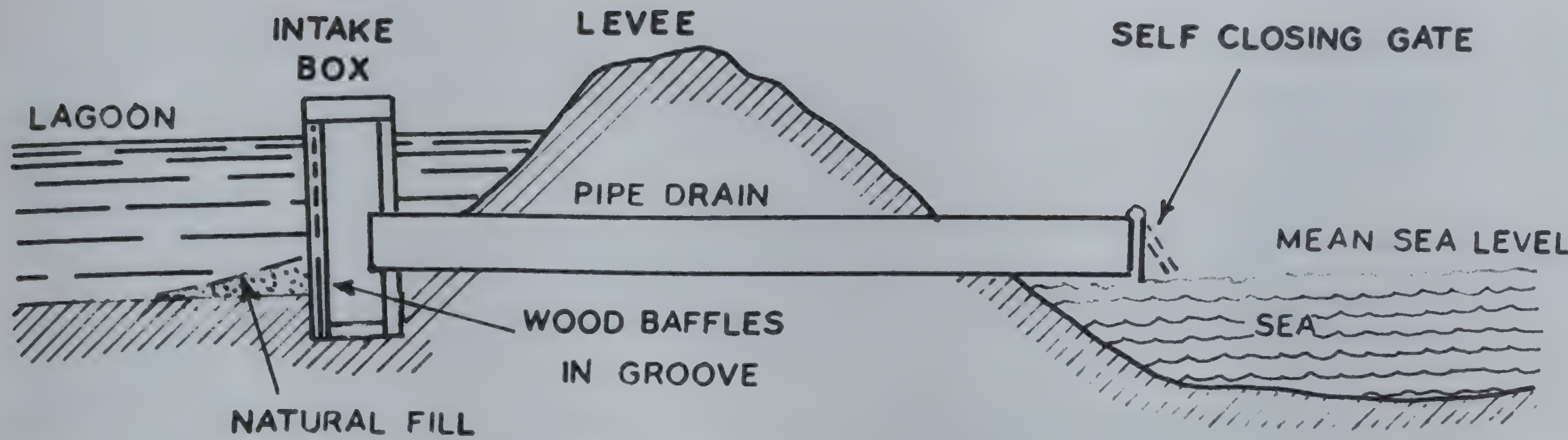


Fig- 8.31 : Gravity Drainage of a Lagoon into the Sea

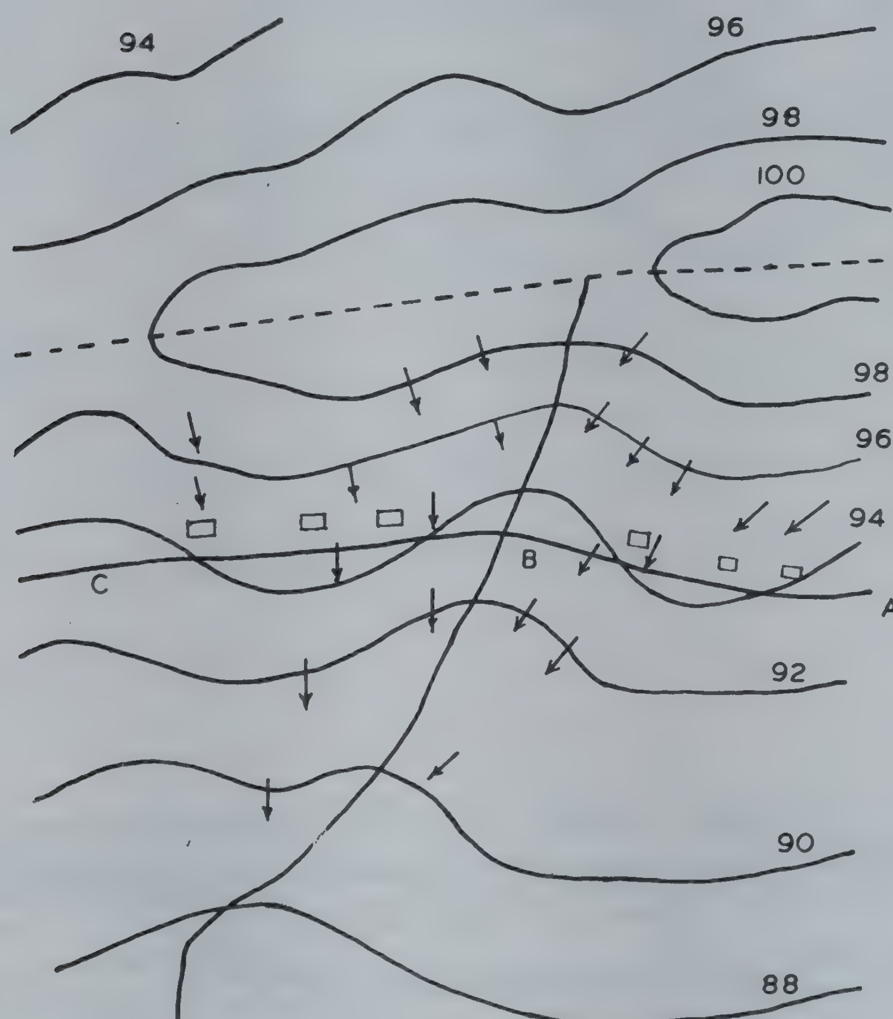


Fig- 8.32 : Water Logging due to Construction of Bank

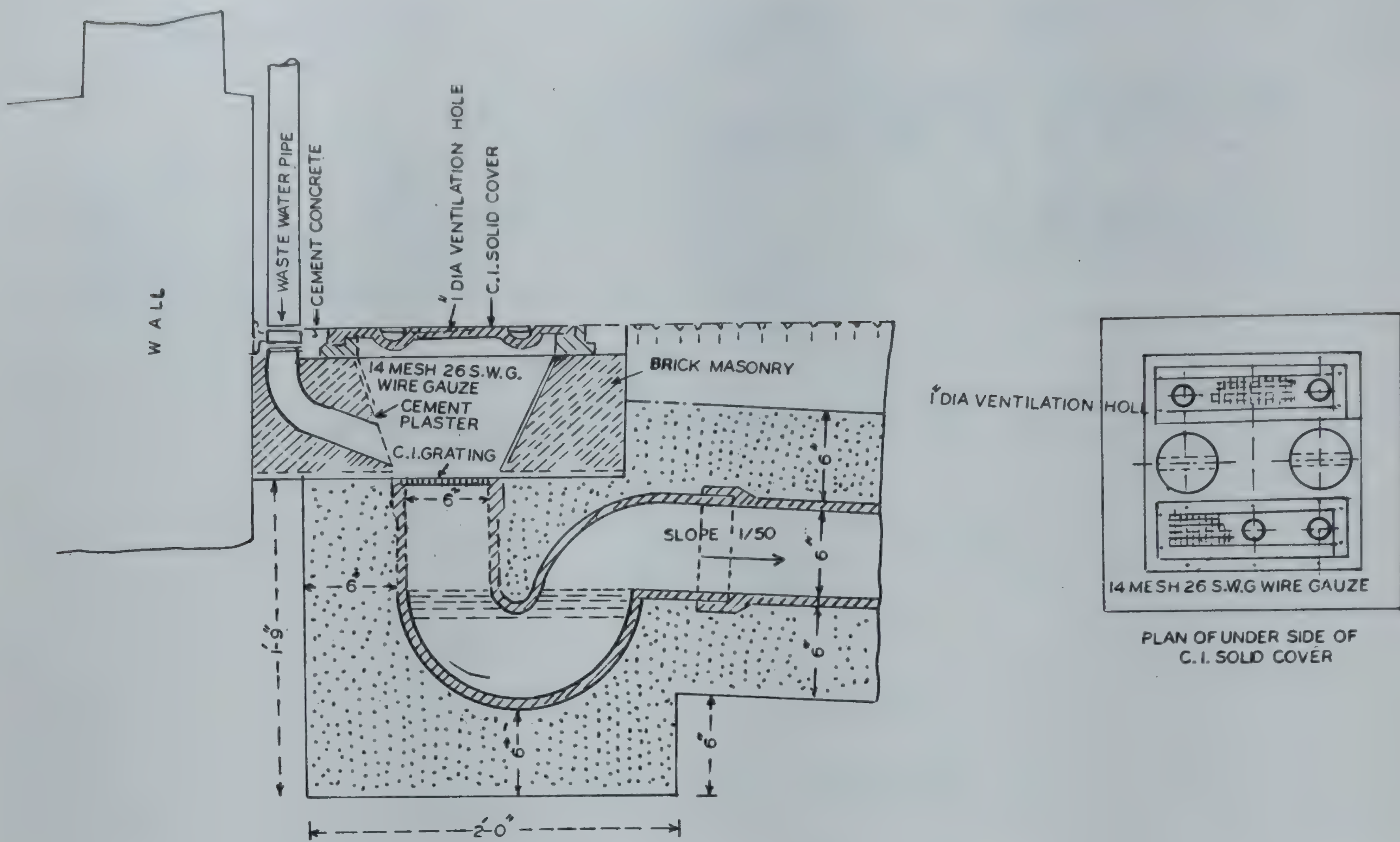


Fig- 8.33 : Mosquito-Proof Gully Trap

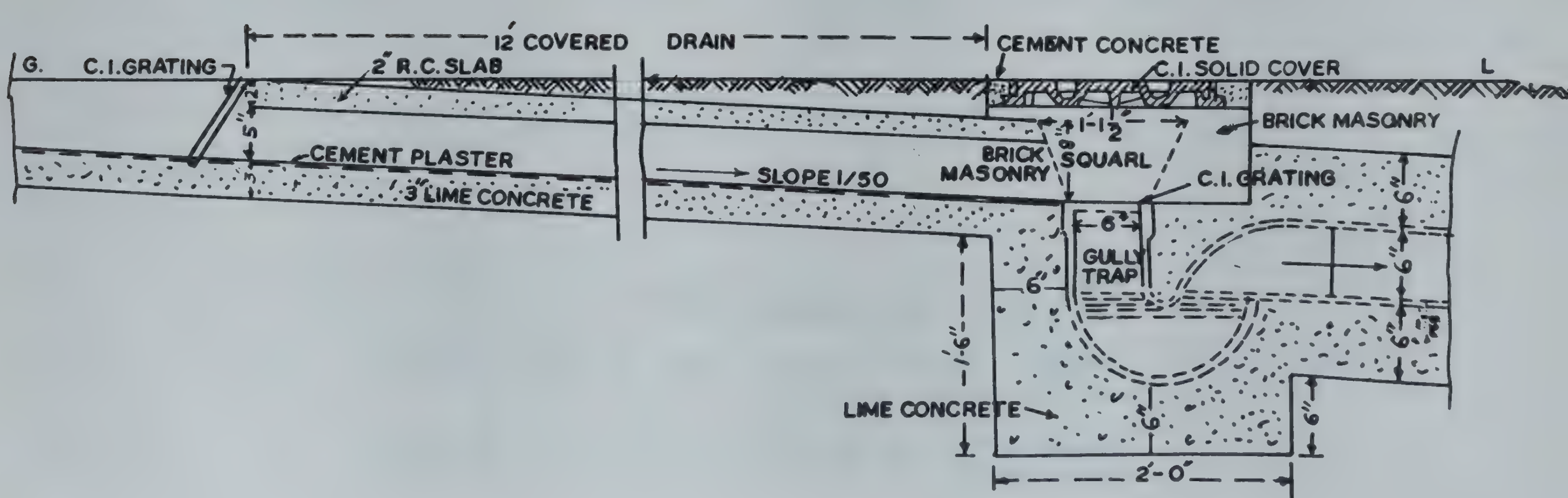


Fig- 8.34 : Mosquito-Proof Gully Trap with 12-Foot Offset Connection

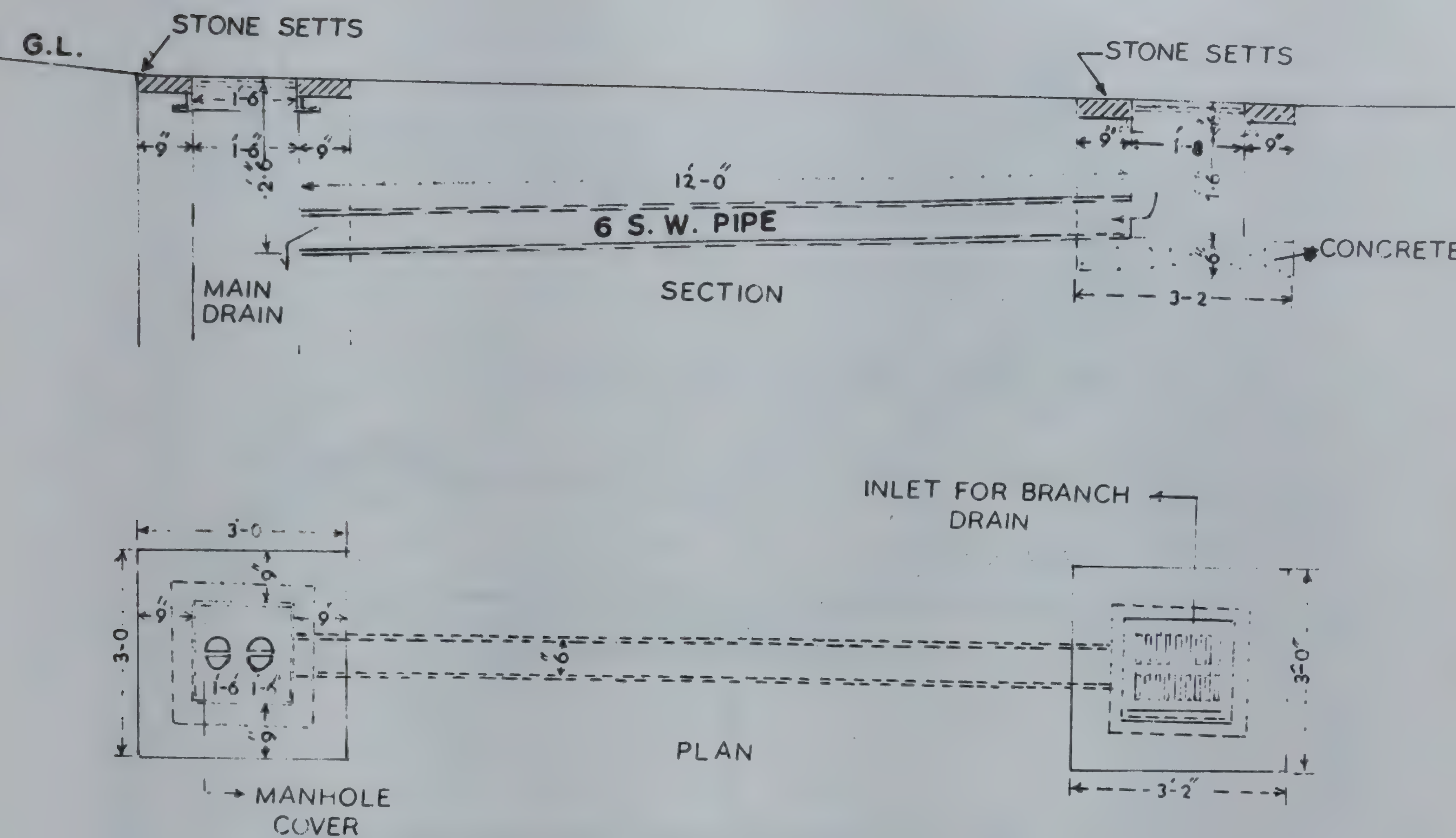


Fig- 8.35 : Mosquito-Proof Connection of a Branch Drain with Main Drain

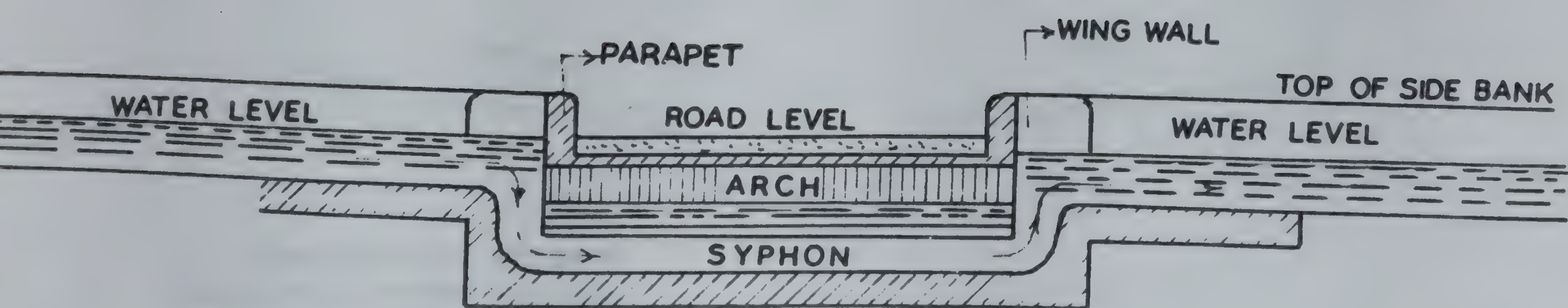


Fig- 8.36 : Undesirable Siphon Under Culvert

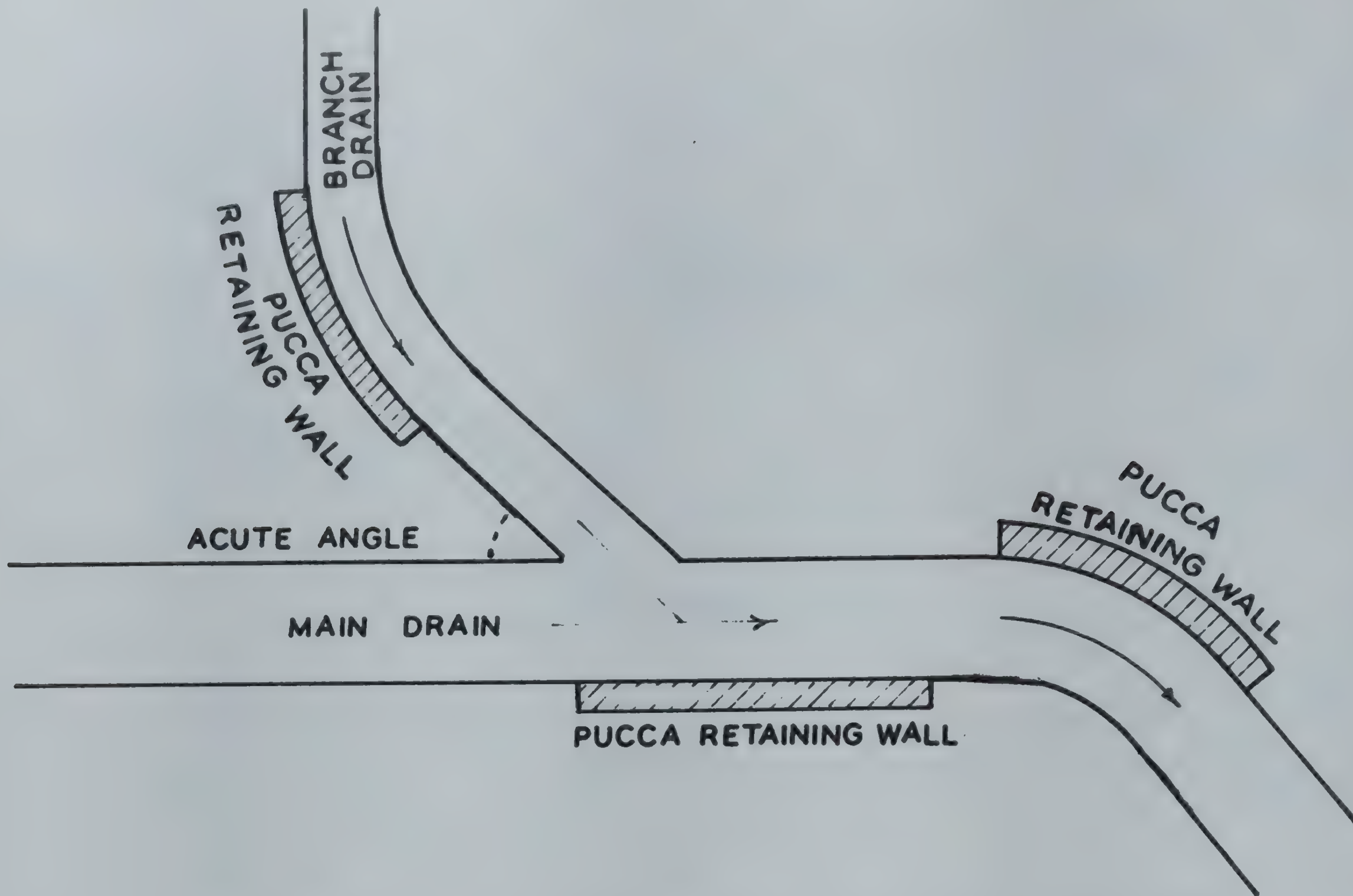


Fig- 8.37 : Plan of Junction of Branch Drain with Main Drain

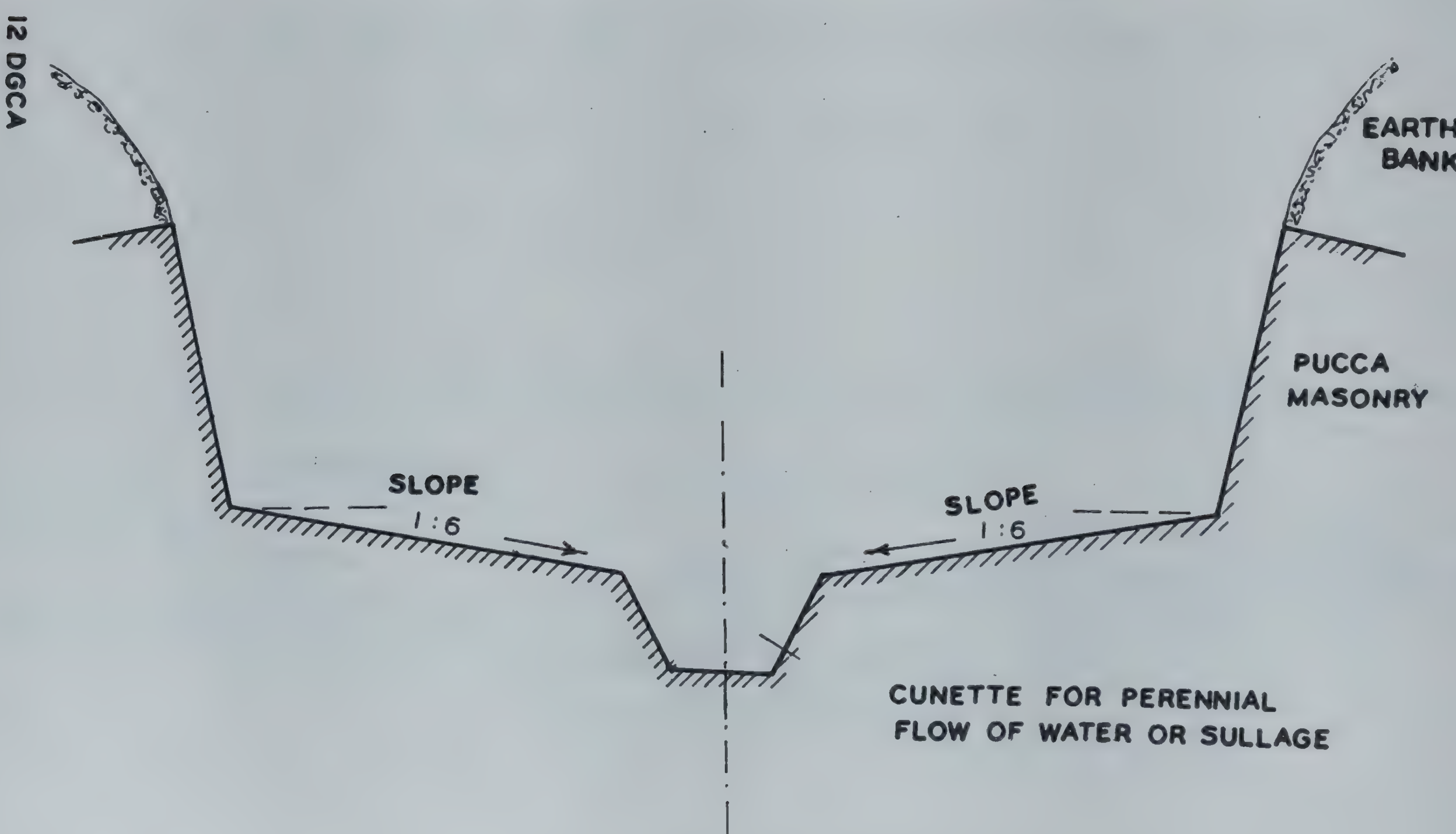


Fig- 8.38 : Section of Storm Water Drain with Cunette

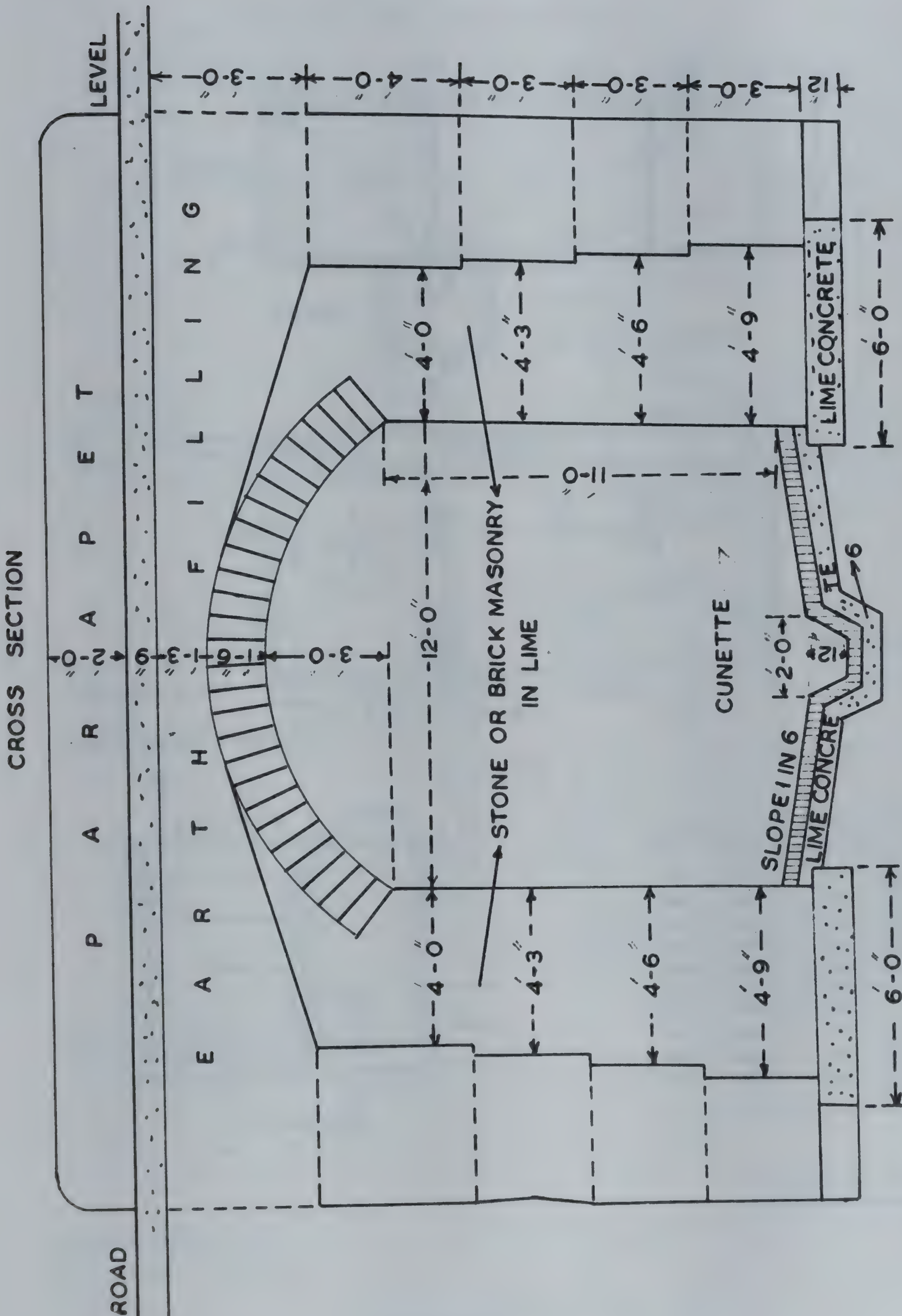
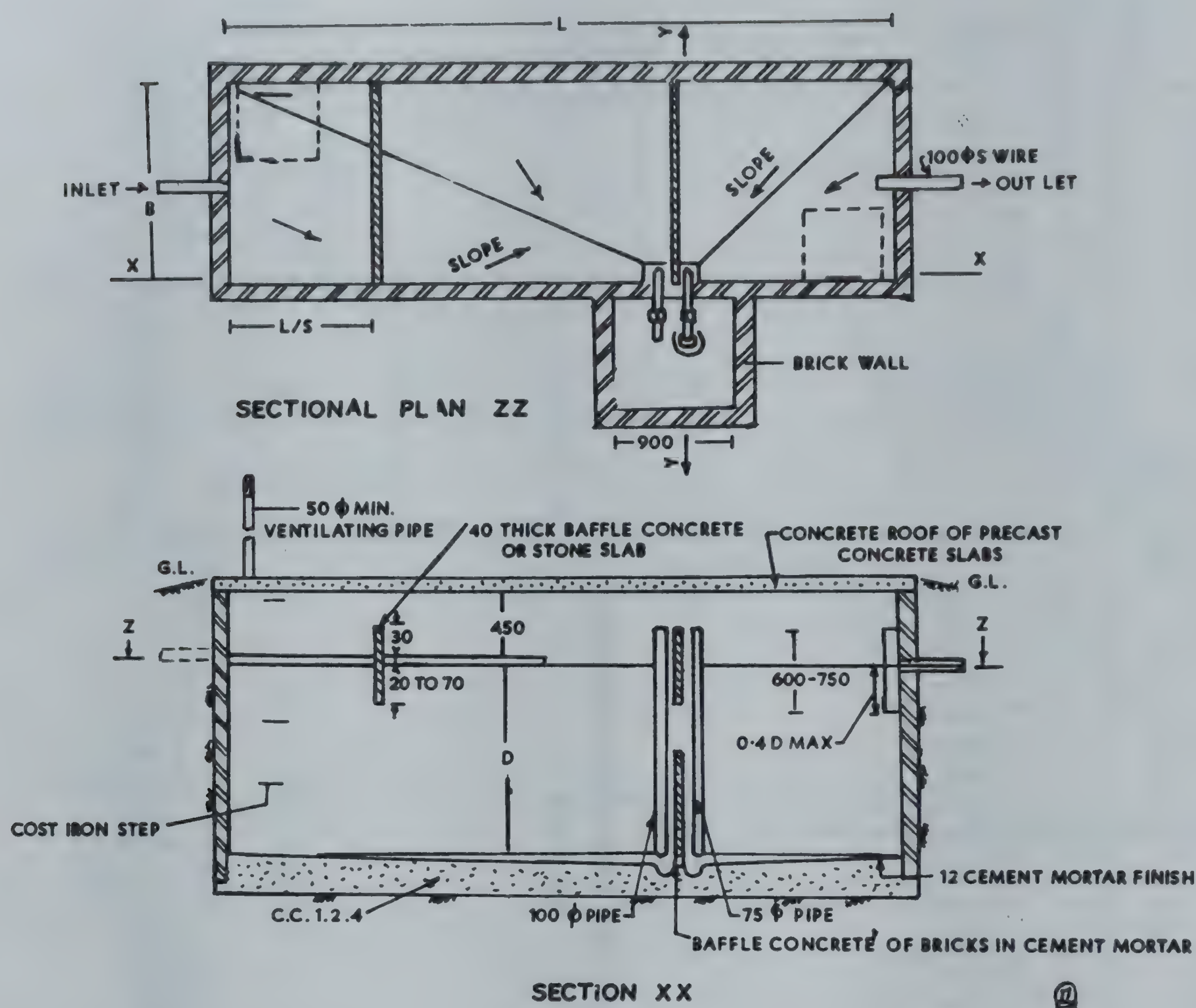
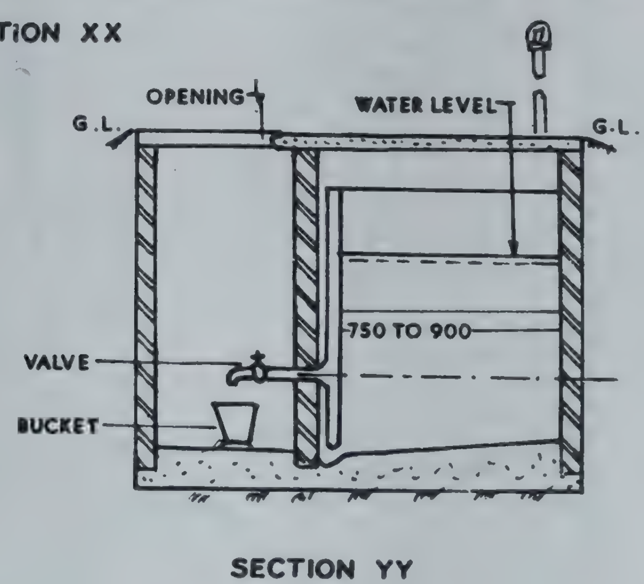


Fig- 8.39 : Road Culvert with a Cunette

CLAUSE-20·13

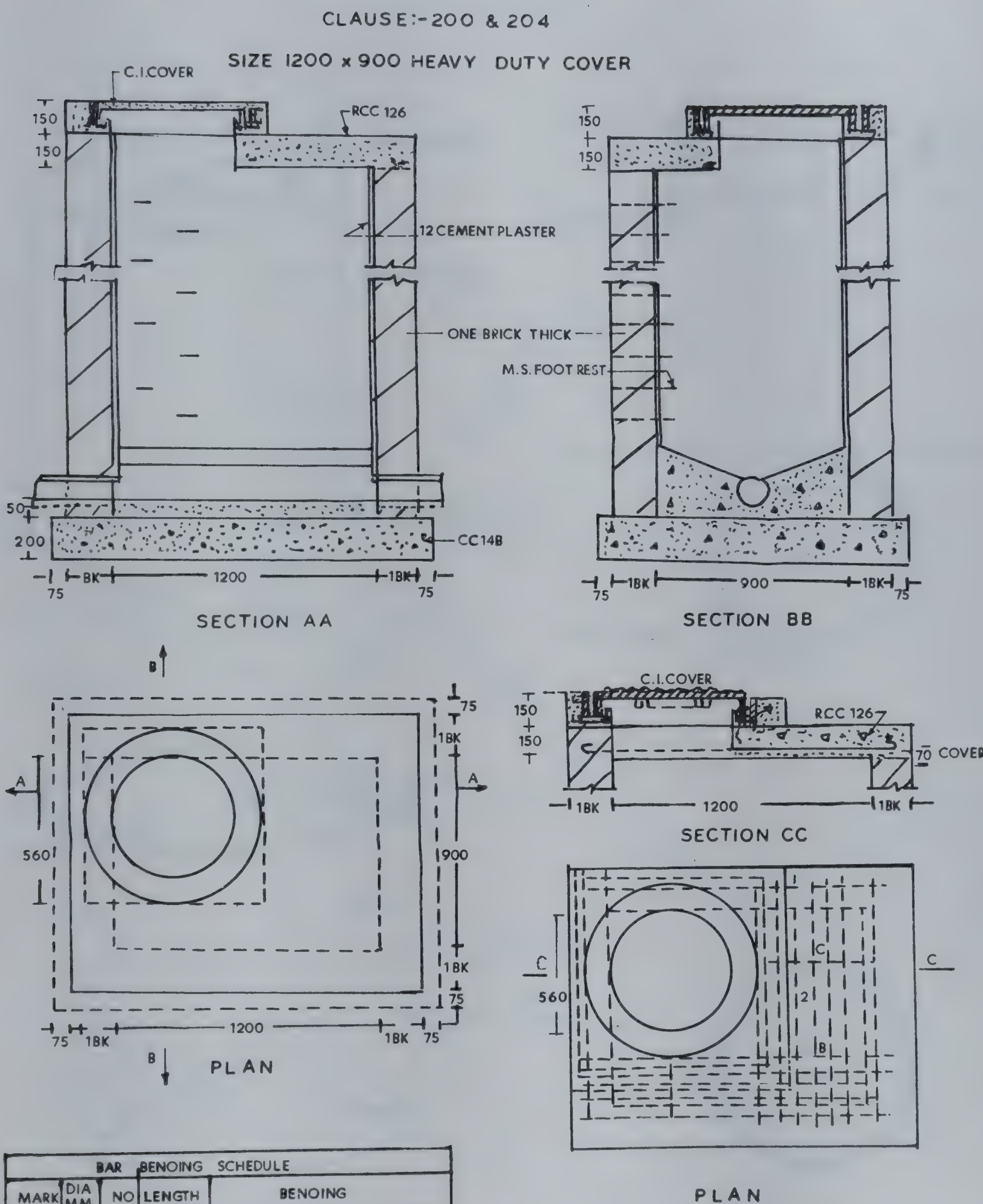


	SIZES OF SEPTIC TANKS		
	NO OF USERS	LENGTH	WIDTH
FOR HOSTEL AND BOARDING SCHOOL	50	5000	1600
	100	5700	2100
	150	7700	2400
	200	8900	2700
	300	10700	3300
FOR HOUSING COLONIES	100	8000	2800
	150	10600	2700
	200	12400	3100
	300	14600	3900



DRAWING NOT TO SCALE
ALL DIMENSIONS ARE IN MM

Fig- 8.40 : Septic Tank



BAR BENDING SCHEDULE				
MARK	DIA MM	NO	LENGTH	BENDING
A	12	4	1200	100 — 1000 — 100
B	12	4	1100	100 — 1100 — 100
C	12	1	500	100 — 300 — 100
D	12	1	625	100 — 425 — 100

DRAWING NOT TO SCALE
ALL DIMENSION ARE IN MM

Fig- 8.41 : Manhole

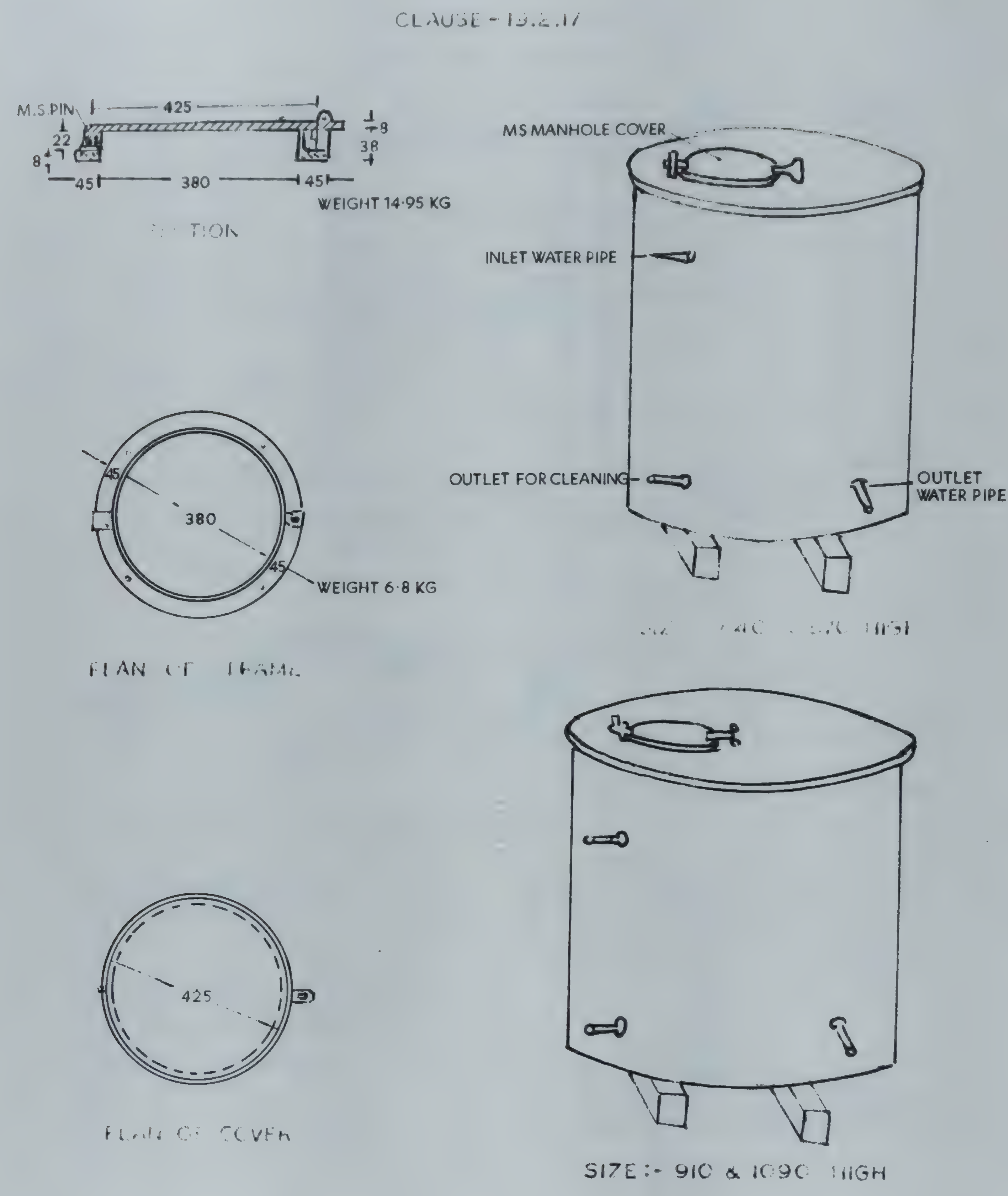


Fig- 8.42 : Precast R. C. C. Water Tank

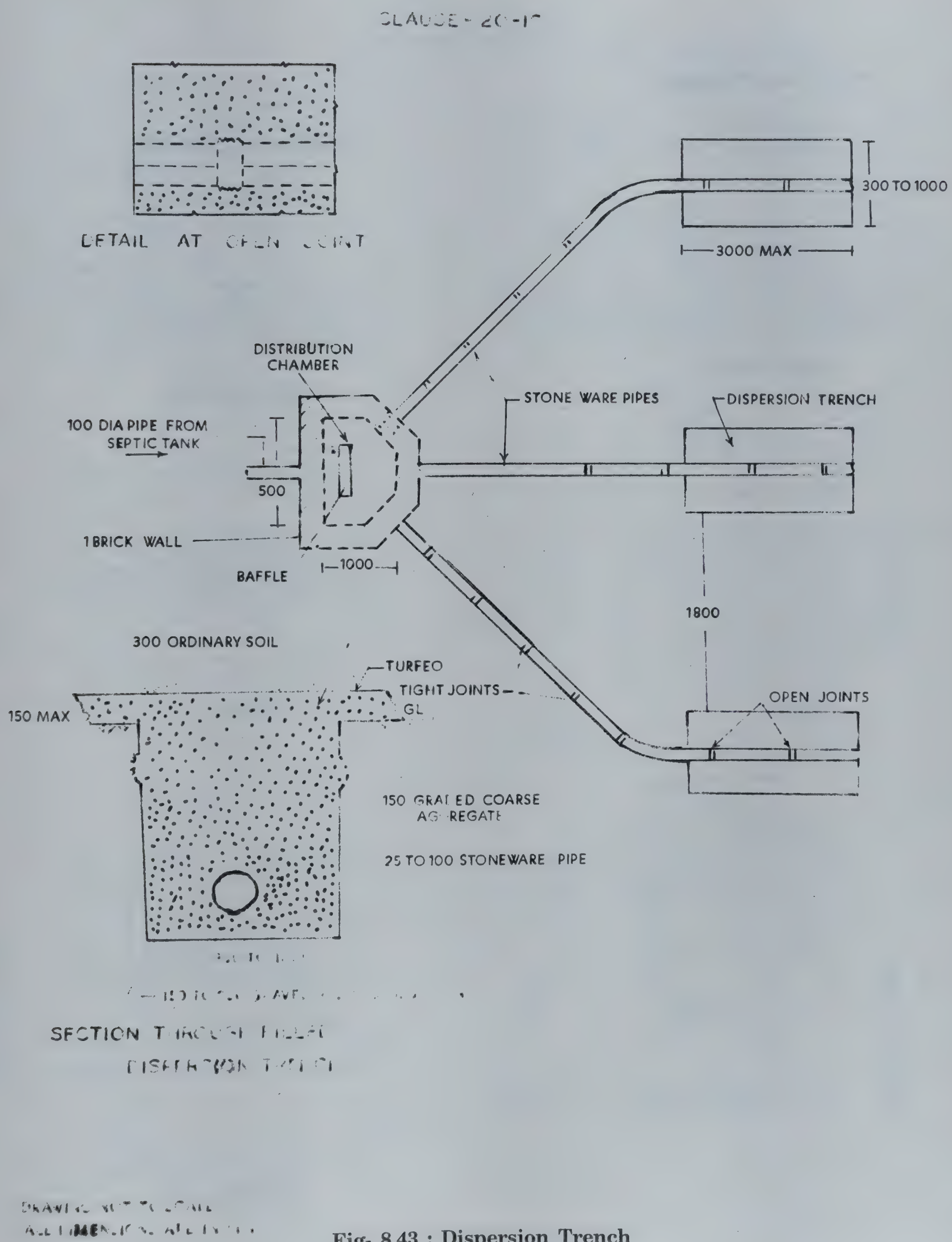


Fig- 8.43 : Dispersion Trench

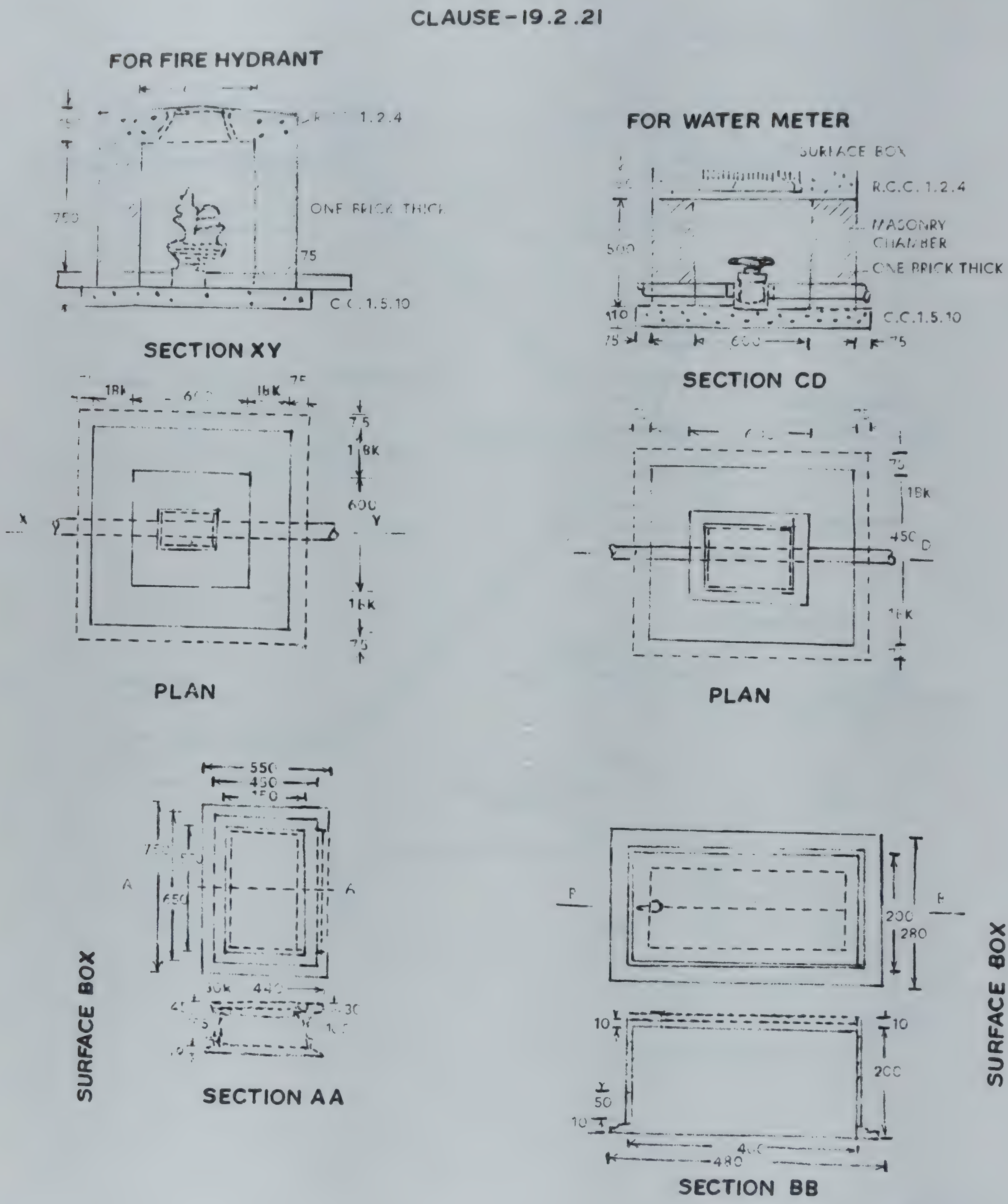


Fig- 8.44 : Masonry Chambers & Surface Boxes

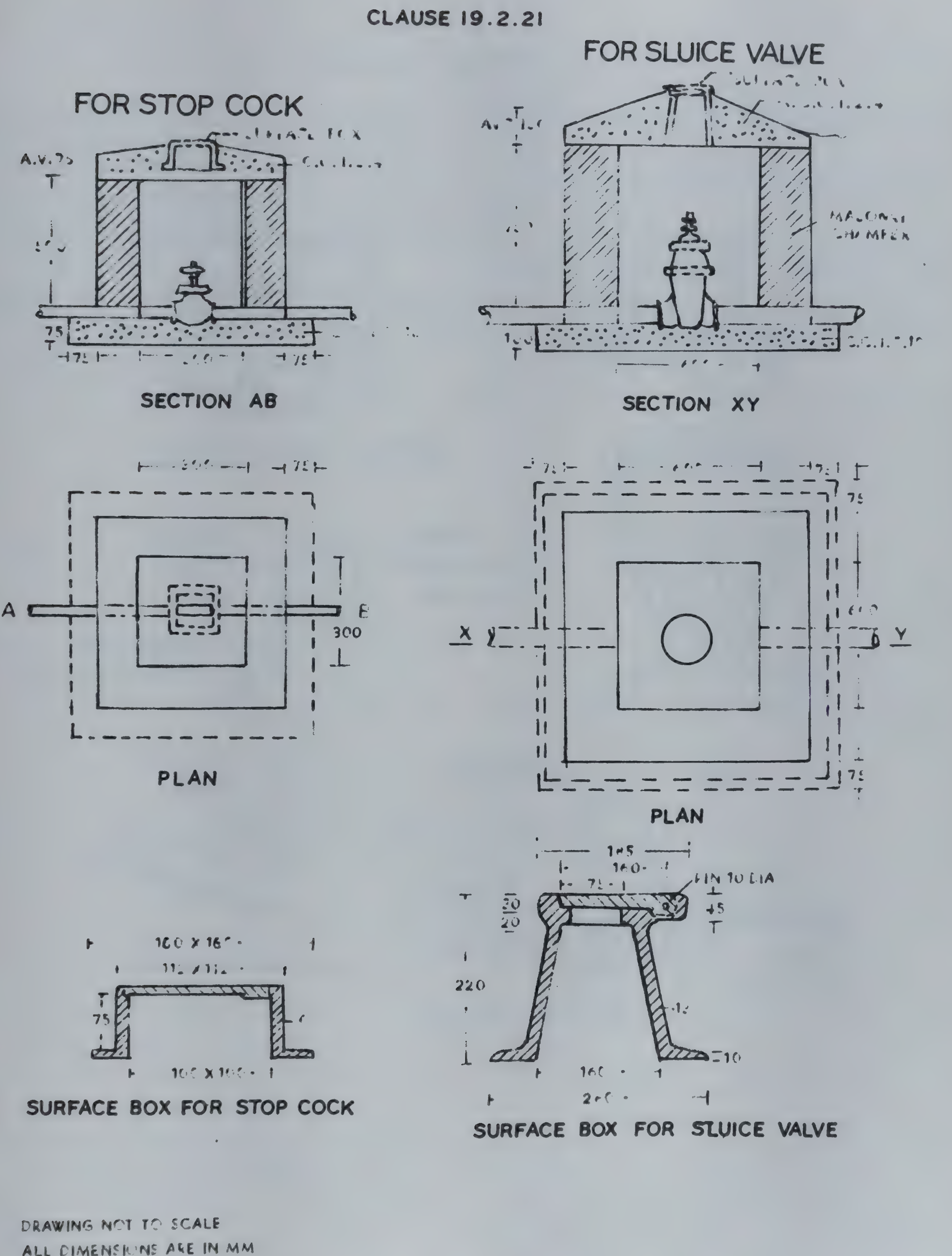


Fig- 8.45 : Masonry Chambers & Surface Boxes (Contd.)

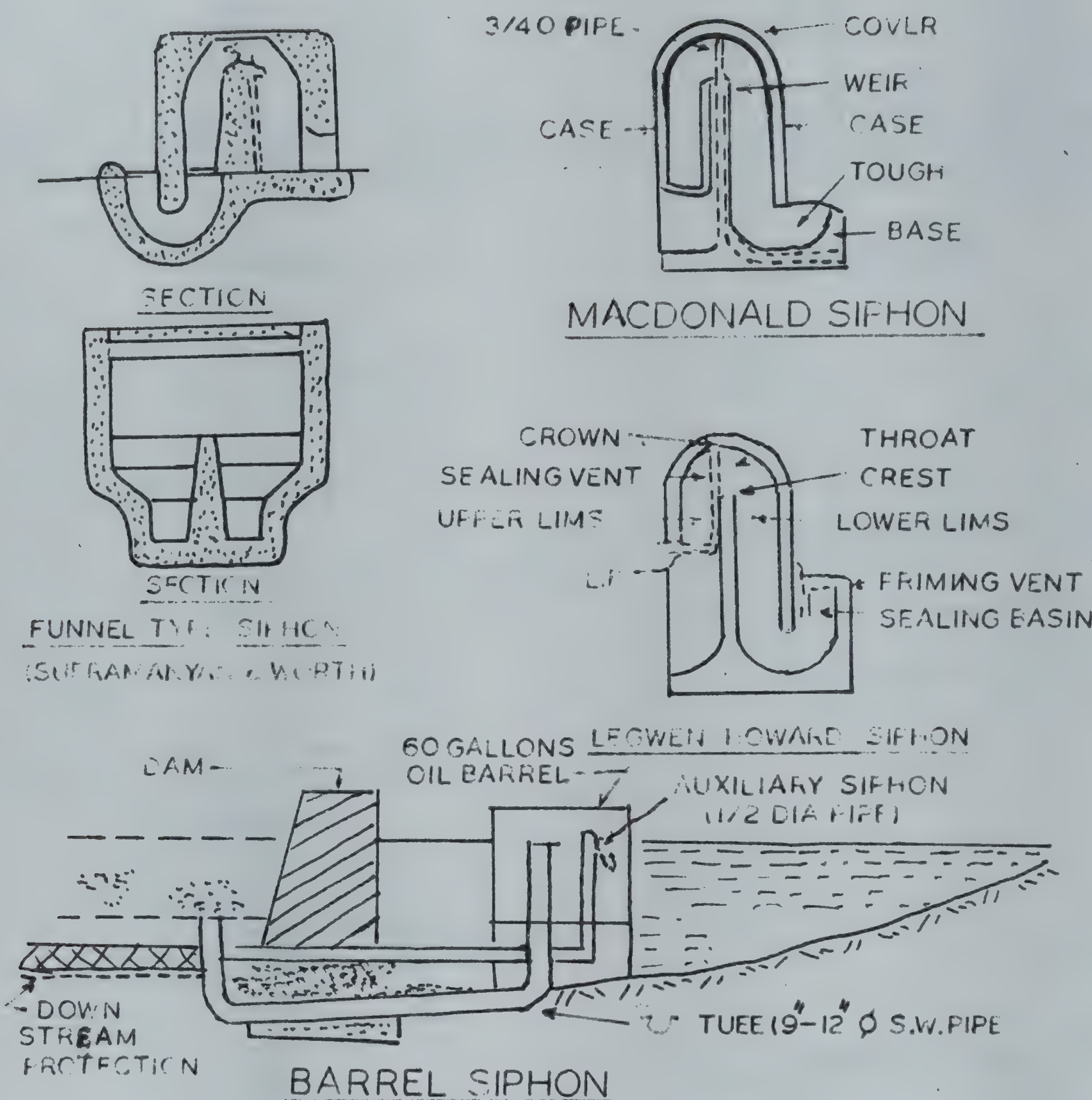


Fig- 8.46 : Different Types of Siphons

SELECTED REFERENCES

1. Panel of Experts on Environmental Management for Vector Control (PEEM) - Report of the Second Meeting, Nairobi, 14-20 Sept. 1982.

2. Subba Rao, S. (1981): Mosquito Breeding *vis-a-vis* Town Planning-WHO Workshop on Regional manpower requirement for Urban Malaria/Mosquito Control Programme, Hyderabad, Oct-Nov. 1981.

3. Subba Rao, S. (1981): Engineering Aspects of Mosquito Control Operations in Urban and Peri-urban Areas - WHO Workshop, Hyderabad, Oct-Nov., 1981.

4. World Health Organisation (1967): The Education of Engineers in Environmental Health. *Tech. Rep. Ser. No.* **376**.

5. World Health Organisation (1977): Engineering Aspects of Vector Control Operations. *Tech. Rep. Ser. No.* **603**.

6. World Health Organisation (1980): Environmental Management of Vector Control. *Tech. Rep. Ser. No.* **649**.

7. World Health Organisation (1982): Manual on Environmental Management for Mosquito Control. WHO Offset Publication No. **66**

9

CONTROL OF MALARIA AND OTHER VECTOR-BORNE DISEASES : NEED ASSESSMENT FOR TRAINING AND CAPACITY BUILDING

INTRODUCTION

Control of malaria and other tropical diseases in India is constrained by limited institutional capacities. As the control of these diseases is a part of the comprehensive health care services, delivered mainly through the primary health care system in the country, capacity building for the control of the tropical diseases should be an integral part of the overall health care delivery system.

Strengthening of the capacities of national health services both in general as well as specialized areas like control of vector-borne diseases should be directed towards the crucial needs of the country in terms of developing appropriate training material, training institutions and trainer cadres.

There could be three major strategies for the development of capabilities among the personnel connected with health programmes. These are :

i. Building capacity

ii. Strengthening capacity

iii. Enhancing performance

In the initial stage of development, the greatest effort must concentrate on building capacity. Capacity means the potential for performance and the main challenge is to arrange the building blocks for disease control. With the basic capacity established, strategies can be devised for strengthening some of its elements. Once capacity is no longer a problem, the strategy should focus on enhancing the performance of the system. These strategies are not to be considered in a linear fashion but need to be adopted to suit the circumstances.

Each strategy has a set of requirements. Capacity building involves a major effort to develop the basic organisation design, infrastructure and human resources. To build this capacity, technical assistance becomes a fundamental requirement.

Enhancement of individual as well as institutional capacities, infrastructure strengthening and quality control are the essential components for the control of malaria and other tropical diseases. This necessitates a multi-pronged approach.

Capacity building at the **community level** should aim at providing awareness of the existing health care services and their utility and limitations so that the acceptance and utilisation improves.

At the **organisational level**, it should aim at improving the performance; it should also facilitate

career opportunities for the health workers of all categories.

To achieve these objectives, identification and strengthening of important public health institutions in the country should be taken up so as to improve the efficiency and effectiveness of the National Health Programmes. Imparting training to NGOs as well as selected private institutions also may be taken up according to the availability of the resources. This encourages public-private partnerships for health programmes.

Capacity building at different levels of the health care delivery system requires needs assessment, time studies, work studies and developing appropriate training methodologies and infrastructure. Training is the most important component of capacity building and full use of the modern educational techniques should be made to make learning more interesting and easier.

Identification of the training needs is an important prerequisite of the training programmes. Training methods should be based on the local conditions and requirements and cost-effective methods of training need to be explored and implemented.

Capacity building is important at all the levels of Health Services (Central, Intermediate and Peripheral). Enhancement of communications and strengthening of infrastructure play a key role in this regard. Training is a very powerful tool to promote stability and organised change, both of which are necessary in disease control programmes.

Setting up of long term and short term objectives, identification of the scope for capacity building within the health care delivery system, framing broad strategies, selection of the project components, planning and mobilisation of resources, incorporation of in-built monitoring and evaluation mechanisms are the major steps for carrying out activities pertaining to capacity building. Identification of the training needs is the essential prerequisite for planning these activities.

TRAINING NEEDS FOR MALARIA CONTROL PROGRAMME IN INDIA

Malaria control activities in India were initiated in the country in 1953 in a systematic way. Training of various categories of health functionaries involved in malaria control was an in-built component of the malaria control programme since its inception. The training needs underwent changes as and when the programme changed its course.

The Programme Planning, Monitoring and Evaluation are under the Directorate of National Malaria Eradication Programme and the training activities are being taken up by the National Institute of Communicable Diseases, Delhi. These training activities involved various categories of health workers.

Capacity building among the higher levels of functionaries like State Programme Officers, District Malaria Officers and Medical Officers is being organised at Central level. Peripheral workers are trained at State and District levels.

The training of the health workers was relatively easier during the days of vertical programme and a large proportion of the workers were covered. It also yielded long lasting results as the staff continuously remained in the programme.

After 1977, with the introduction of Multipurpose Health Workers Scheme in the country, the training needs changed and the worker at the periphery was required to undergo training in multifarious activities.

At the district level, Chief Medical and Health Officer (CMHO) is responsible for implementation of all the health programmes. Four to five Deputy CMHOs have their areas of responsibilities. This has necessitated **saturation** training of all the officers on malaria.

Priorities for Training in Malaria Control

i. Training programmes in the country need reorientation towards Primary Health Care System. Capsular training of all the health programmes for

different levels of functionaries is essential.

ii. Training contents related to management aspects are to be developed and included in the curriculum.

iii. Training of the supervisory categories of staff is required in developing planning skills so as to encourage micro-level planning and to provide supportive supervision.

iv. Training modules are to be developed for different categories of health workers to ensure adequate skills for the management of operational problems.

v. The programme should ensure that all categories of health workers are covered by the training programmes.

Identification of Training Needs

The training needs of the programme have undergone significant changes in consonance with Primary Health Care System. To identify these needs, the following studies are envisaged by the Directorate of National Malaria Eradication Programme, to plan the Training Programmes for the next 10 years.

Identification of Problem Areas

The problems pertaining to the implementation of the malaria control programme may be identified at :

- Community level (Health Promotion)
- Health worker level
- Organizational level
- Environmental level
- Social, political and economic levels

Training Needs Assessment of Health Workers

This is carried out by **performance analysis** of health workers, which will help in identifying the reasons for the constraints associated with the implementation of the Health programmes. After performance analysis, suitable curricula can be designed for different categories of workers.

With the introduction of computers into the Health Programmes, the training programmes are taking a new turn. The Directorate of National Malaria Eradication Programme is envisaging the introduction of revised training programmes for its health workers, so as to ensure better implementation of the malaria control activities in the country.

Performance Analysis Techniques

The Programme envisages taking up the following **Performance Analysis Techniques** to identify the training needs :

i. Estimation of Performance Discrepancy

ii. Time and Work Studies

iii. Questionnaire Methods

iv. Work site Interview

v. Individual Interview

vi. Group Interview

vii. Technical Conference, etc.

i. Estimation of Performance Discrepancy : The gap between the expected level of job performance and the actual performance, which is known as performance discrepancy, should be estimated for each category of workers so as to identify and assess the extent of needs for capacity building. This will facilitate planning of suitable curriculum and syllabus.

ii. Time and Work Studies : These are required to study the time spent by the worker for different components of his/her job functions. This helps in replanning the job functions and also in reallocating duties to different categories of health workers.

iii. Questionnaire Methods : These help in qualitative assessment of the knowledge, attitudes as well as the actual practices of the health workers at various levels of hierarchy regarding malaria control activities. Various socio-metric scales like Likert scale, Thurston scale, etc. can

be made use of in this regard.

iv. **Work Site Interview** : This helps in studying the degree of motivation for performing the prescribed job functions.

Individual Interview, Group Interview, Technical Conference, etc. may be required depending upon the necessity. Individual interview and group interview should cover all strata of the community including different age groups, socio-economic status, educational status, gender, etc.

Organization of Training

After identifying the training needs of the programme and the bottlenecks associated with the smooth implementation of malaria control activities in the country, the "Training Programmes" will be planned accordingly.

This planning involves the following steps :

i. Obtaining **Administrative Clearance.**

ii. Arranging the **required funds for Training.**

iii. Identification of the **Institutes for Training Programmes.**

iv. Preparation of **Training Profile.**

v. Identification of the **Learning Needs** of the trainees at different levels and respective roles in programme implementation.

vi. Training of **Trainers.**

vii. Providing **Training Material**.

viii. Arranging Class Room and Laboratory Facilities.

ix. Residential **Accommodation and Transport.**

x. Arrangement for **Field Exercises.**

xi. **Evaluation** and Follow-up of Trainees.

xii. **Redesign** of Training Modules including Manuals for Trainers' Training.

A **Check list** should be prepared for Planning, Organization and Management of a Training Programme. This checklist, in addition to the above mentioned requirements, should indicate the number of trainees, their profile and training needs and earmarking of the programme personnel for different activities connected with the training programme.

LEARNING PROCESS

Learning Styles

The **Learning Styles** of the trainees should be assessed, wherever feasible, to plan the training activities accordingly. Priority should be given to mini-teaching sessions and group interactions instead of didactic lectures.

Wherever feasible, indigenous teaching material should be selected (especially for Community Educational Activities) according to local cultural practices. Similarly epidemiological exercises should be on local data.

It is proposed to minimise the number of lecture sessions as the receptivity of the participants is low for these sessions. Taking of notes should not be insisted during the lecture sessions as these have proved to be resulting in loss of time for reflection and discussion. Adequate learning material should compensate for learning without note-making.

i. Readiness is an important factor in learning. A person will be ready to learn things that are linked to his/her perceived needs, abilities and interests. Therefore developmental readiness, motivation to learn and attention are three variables that affect readiness.

ii. Frequent repetition will strengthen the Stimulus - Response (S-R) bond.

a. S-R bonds that are used repeatedly lead to the performance of that response.

b. S-R bonds that are in disuse fade away and are forgotten.

iii. If the result of learning or the effects of learning are satisfying to the learner, the learning gets stamped in. But if the result frustrates or

annoys the learner, the learning is stamped out.

iv. Acts of learning that are related and relevant to one another will be learnt more easily than discrete and unrelated acts.

The Process of Learning

The learning process is complex and multi-dimensional. It is difficult to analyse and is often over-simplified. Some important components of learning process are :

i. DRIVE : initial motivation - 'wanting to learn something'.

ii. CUE : Awareness of situation, milieu and stimuli that make learning possible.

iii. RESPONSE : Task performance and (or) learning activity

iv. REINFORCEMENT : Satisfaction of completing the task/activity.

Sequence of Events in Learning (Response & Reinforcements).

A. Learning

i. **Apprehending phase** : consisting of attending, perceiving and coding.

ii. **Storage phase** : consisting of retention and memory storage.

B. Remembering

i. **Storage phase** : consisting of retention and memory storage.

ii. **Retrieval phase** : consisting of recognition, recall, reinforcement and transfer of skill.

C. Performing

Actual performance of the job.

Types of Learning

Learning has been classified into :

i. Discrimination Learning

The ability to distinguish among many similar looking ideas, stimuli or objects. Highly distinctive stimuli help learn discrimination. Learning is gradual and needs practice and corrective feedback.

ii. Concept Learning

The ability to classify stimuli in terms of abstracted properties or characteristics (e.g. syndromes). Concept attainment does not need a verbal definition but is learnt intuitively.

A variety of stimuli incorporating the conceptual property to be learned are presented. Then the property is discriminated and concept attained.

Learning a brand new concept is a gradual process but once attained, remains relatively permanent.

iii. Rule - Learning

A rule is chain of two or more concepts - usually a relation between those concepts (e.g. rules of correction of electrolyte imbalance).

iv. Problem - Solving

Once learner acquires some rules, they could be used for solving problems. Learning of the highest order takes place. This is also called vertical transfer of learning.

Ensuring Learner's Attention

The best lesson given by a teacher is of little value unless the learners pay attention. **Attention** is not some unique mental power - it is a process or an activity and so **attending** may be a better word than attention.

Attending (or attention) can be defined as 'the mental activity of focussing on certain aspects of one's current experiences and ignoring others'.

To secure the attention of students, the following strategies may be tried:-

a. Remove certain obstacles to attention *viz*. poor physical condition of the student, uncomfortable class room and seating, inadequate lighting and ventilation, distracting stimuli like noise, etc.

b. Make good use of objective factors of attention like loud voice, clear expression, striking

audio-visual aids, stimulus variation, humour, etc.

Principles of Learning

i. Learning is personal - different students learn different things by different means and at different rates.

ii. Learning under intrinsic motivation is preferable to learning under extrinsic motivation.

iii. Learning must be aimed at realistic goals.

iv. One of the most important factors influencing learning is what the learner already knows - ascertain this and teach him accordingly.

v. Active participation by the learner is preferable to passive reception.

vi. Learning should be experience-centered and the experience must be meaningful to the learner.

vii. Learning depends on a satisfactory climate - climate characterized by good interpersonal relationships.

viii. Emotion perhaps nearly as much as intellect as cognition is involved in the learning process.

ix. Learning under the control of reward is usually preferable to learning under the control of punishment.

x. Learning should be accompanied by feedback - the learner must know how he is progressing with respect to a given set of goals.

xi. Transfer of learning to new tasks will improve, if in learning, the learner can discover relationships for himself.

xii. Integration and correlation of subject matters will help in efficient and effective learning.

Taxonomic Domains cf Learning

One third of what we listen is lost within half an hour and most of it is lost in 3 to 4 hours. This happens more so when we impart knowledge by didactic lectures without active involvement of the learners. In order to make the training programme effective to the extent of having appropriate attitude and skills in addition to the knowledge, various taxonomic domains may have to be considered according to the requirements of the learner.

A domain is a device for classifying things in terms of certain of their characteristics; thus, it identifies the relationship of one thing to another in terms of these characteristics.

Taxonomies are devices of human origin that not only help teachers to label objectives in terms of one or more properties, but also to get some ideas of the sequences in which objectives may best occur, thus contributing to their validation. This leads to the fact that taxonomies attempt to be hierarchical, that is, organised into levels or ranks.

1. Cognitive Domain

This domain is concerned mainly with description of learning designed to acquire, recall or recognise knowledge and the development of intellectual abilities and skills of the students. This is also referred to as domain of intellectual skills.

2. Affective Domain

This domain deals with description of learning tasks concerning changes in interest, attitudes, values and the development of appreciations and adequate adjustments. This is often referred to as the domain of communication skills as this domain mainly deals with interpersonal relationships.

3. Psychomotor Domain

This domain deals with acquisition of physical abilities, motor or muscular skills, manipulation of materials and objects or acts requiring a neuromuscular coordination. The psychomotor domain involves mind and the perception, as it is through perception that a learner becomes aware of himself and his environment through various sense modalities and performs practical skills

Hence, this domain is also referred to as domain of practical skills.

The categorisation of the objectives into domains has been done with the full realisation that there is some inter-mixing and overlapping between the domains. The only purpose of these classification systems is to permit analysis of the learning process and to help teachers in educational decision making.

It is well known that cognitive or factual elements are necessary for performing a complex skill. In addition, the learner's feelings and attitudes may also affect his/her performance of receiving information about anything.

The above examples only indicate the interdependent nature of one domain on the other, but nevertheless, the outcomes can be classified as falling predominantly into one major domain.

Depending on the outcome desired, objectives can be classified. This would enable choosing appropriate teaching/learning methods and evaluation measures.

Cognitive Domain - Simplified Classification

i. Knowledge - recall

ii. Interpretation of data - understanding

iii. Problem solving - application

Affective Domain - Simplified Classification

i. Receiving

ii. Responding

iii. Internalisation

Psychomotor Domain - Simplified Classification

i. Imitation

ii. Practice under supervision/guidance

iii. Performance with high degree of skill (proficiency)

For most categories of health workers under malaria control programme psychomotor skill learning is considered to be the most ideal method for imparting training as the control activities are to be conducted in field situations and require technical skills. To provide psychomotor skills to the trainees, simulation models will be of practical value.

4. Simulators for Psychomotor Skill Learning

For teaching-learning of skills (Psychomotor), simulation models or mannequins may be used to provide students the experience and repeated practice before they work with more expensive equipment or seriously ill patients.

The skills are taught by

- Describing the skill
- Demonstrating the skill
- Allowing students to practise the skill

There is no doubt that 'on job' experiences are the best in the development of knowledge, skills and attitudes but under some circumstances, simulation devices will provide better facilities for mastering the skills.

Simulators are useful when the reality is:-

i. Not available

ii. Dangerous to students

iii. Dangerous for patients

iv. Too expensive in time and space, etc.

v. Unpredictable

vi. Too complicated or complex

vii. Time consuming

viii. Confused, masked or dampened by extraneous noise.

These simulators can be used not only as Teaching/Learning (T/L) aids but also as

assessment tools.

TEACHING PROCESS

Teaching is a discipline which involves combination of science and art. There are many methods of teaching and the selection of appropriate method is the most important prerequisite for any training programme. A brief outline on various teaching methods is as follows:

Large Group Teaching

Learner group consisting of 30 or more persons.

i. Lecture:

This is a careful presentation of facts with organised thoughts and ideas by a qualified person.

ii. Symposium

A symposium is a series of prepared speeches given by a few experts (2 to 5) or spokesmen on many aspects of a topic or a problem under a chairperson. The talk should be short and to the point (10 to 25 minutes). There is no discussion between speakers. The audience is passive except at question time towards the end.

iii. Panel

A group of four or more persons under a moderator who have special knowledge of the topic, sit at a table in front of an audience; they hold an orderly and logical conversation on an assigned topic. Each member makes an opening remark (for 3-5 minutes) before exchanging ideas.

Small Group Teaching

Learner group consisting of less than 30 members.

Group Discussion

This may be defined as a face to face interaction between members of a relatively small group (usually 5 to 20 persons). The group interaction as a **method** and a **structure** but it can still be **informal** and **democratic**. To be more than just a random unstructured conversation, the group members should have a **common concern** regarding a problem to be solved, a decision to be made or a desire for information.

Group discussion has many advantages to make it an effective T/L method. Some of them are:

i. This is democratic and demands discussion on the experience of the learner.

ii. Learner discovers his strengths and weaknesses in comparison to fellow-learners and gains new insight.

iii. Provides opportunity for the synthesis of varied T/L experiences and data (e.g. from lecturers, laboratory, clinical and bed-side teaching and text book reading).

Other Methods Related to Group Discussion

i. Controlled Discussion

In this method, the general direction of discussion is strictly controlled by the teacher, i.e. it is not democratic like a group discussion.

Normally used at the end of a presentation to a class (large group), to help in revision of facts, understanding and feedback.

ii. Free Group Discussion

Here the teacher acts as an observer and the student group controls the topic and discussion.

This method helps change in attitudes, feelings and human relations; improves observation, self awareness and willingness to receive and consider new ideas.

iii. Buzz - Group

Here, groups of 2 - 6 members discuss issues or problems for a brief period within a lesson.

Encourages group cohesion and reticent students; active learning progress; break from monotony of a long lecture. Buzz groups could be allowed within a lecture to help 1) Consolidate memory, 2) learn new terminology by usage and 3) gain arousal feedback.

iv. Brain Storming

This is an intensive group discussion where spontaneous ideas and solutions to a problem are received without criticism.

v. Seminar

This consists of a group of persons engaged in advanced study of a subject (or research in related fields) meet under the general direction of an expert staff-member. This form of group discussion leads to an in-depth study.

vi. Tutorial

Here, a small group of learners are guided by a teacher to help clear doubts, improve understanding and enhance knowledge of the subject.

a. Active learning situation, **b**. ideal teacher-student ratio and **c**. opportunity to correct mistakes and to find out extent of learning are the advantages of this method.

vii. Demonstration

This is a method where a teacher performs some operations (e.g. indoor residual insecticidal spray) to demonstrate skills or phenomena while the students watch.

Advantages: Observation of skills; knowledge of the principles and the skill demonstrated.

viii. Practical/Field Work

Advantages :

a. Active learning process

b. Limited group of learners

c. Permits evaluation of **all three domains**

d. Bridges the gaps between theoretical knowledge and practical reality

e. Develops qualities of **scientific thought.**

Disadvantages :

a. High personal costs

b. Poor standardisation

c. Cases (Patients) may be put in difficult situation.

ix. Role Play

Acting out a situation. It enables a group to study the behaviour of role-players. Develops empathy and self-awareness; works off tension; creates attitudinal change. It is an effective method for manipulating attitudes (affective domain).

x. Workshop

A meeting during which experienced persons in responsible positions come together with experts to find solutions to problems that have cropped up in the course of their work.

Advantage: Active involvement by each participant who will work and learn from **Practical (hands-on) experience.**

Disadvantage: A lot of ground work and initial preparation are needed to make workshop effective and successful.

The annual review meetings of the control programmes involving State Programme Officers can be conducted in this fashion whereby active participation and exchange of views can be ensured. In large countries like India, these can be organised at regional levels.

Individual Teaching/Learning

Reading is an effective method of self-learning of facts, which are not too difficult to grasp without guidance. Reading develops thinking and ability to seek out and acquire information. Teaching with the help of 'Operational Manual' is one of the methods to impart training through reading. These will particularly be very useful for the middle level managers at the periphery.

Programmed Learning: A method of self learning using a programmed set of instructions (using a work book, a mechanical or a microprocessor device) to help the learner attain a specific level of performance.

Advantages:

a. Provides instructions in small steps.

b. Provides instant feedback on learner responses, right or wrong and

c. Enables learners to progress at their own pace (useful for slow-learners).

Conference

This is a one to one interaction between a teacher and a learner where individual needs can be dealt with. Useful in sorting out problems of low-achievers, slow-learners, absentees, etc.

Simulation

A teaching method in which a real situation is simulated by various means (on paper, using models, using live, mechanical or computerised simulators). The learner plays an appropriate role to tackle the situation.

Simulation has a very varied scope depending on how it is put to use. It can develop psycho-motor skills for problem solving ability or bring about attitudinal change and self-awareness.

OBJECTIVES

Framing Objectives for the Training Courses

'The most important thing about education is appetite'

'The end of education is not knowledge but action'

- Framing of general and specific objectives will precede curriculum designing and syllabus drafting.

- After analysing the basic concepts of needs assessment, learning styles and requirements, teaching methods and teaching equipment, the organisers should finalise **objectives for training** various categories of the health workers.

Some Action Verbs Used in Stating Objectives for Imparting Training through Various Taxonomic Levels of Learning :

The learner should be able to acquire knowledge and skills for improving performance levels at the end of the training session.

According to the type of teaching imparted, he or she should be well conversant with the following tasks :

Cognitive Domain:

Compare	Contrast	Identify	Distinguish
Explain	List	Enumerate	Describe
Select	Specify	Relate	Infer

Psychomotor Domain:

Dissect	Palpate	Perform	Inject	Insert
Operate	Auscultate	Identify	Prepare	Remove

Affective Domain:

Respond	Cooperate	Display	React
Receive	Participate	Permit	Contribute
Interact	Analyse data		

CURRICULUM

Syllabus and Curriculum

Syllabus is the summary brief of the contents of the course within the prescribed time schedule. Allotment of time slots for each component of the curriculum is the main purpose of syllabus.

Curriculum is a plan of educational activities. It states general and specific objectives, indicates selection and organisation of contents (subjects, scheduling timetable, giving list of books), mentions/suggests certain patterns of learning and teaching, and a programme of evaluation of the learning outcomes.

Curriculum Designing

Before finalising curriculum for each training course, the following points should be kept in mind :

a. Statement of general and specific objectives.

b. Selection and organisation of content.

c. Selection of patterns of learning and teaching.

d. Programme of evaluation of the learning

outcome.

e. Timetable

f. Reference books.

Principles of Curriculum

1. Curriculum is a Dynamic Subject

As the social and health needs change from time to time there is need for revision of curriculum. No single curriculum is suitable for all the times. The curriculum has to change in accordance with the changes in health problems, disease conditions, scientific development (e.g. newer insecticides, vaccines, etc.) and social advancement.

2. Curriculum to Meet Needs and Objectives

The needs, demands and requirements of the people (health) in a society have to be fulfilled through the experiences provided. These experiences are planned and spelt out in the curriculum.

3. Curriculum Development implies a Scientific Process of Education

The different stages involved in the curriculum process i.e. objectives, contents, experiences, organisation and evaluation make the curriculum a scientific process. It is no more based on rigid tradition but supported by social, economic and provisional traditions.

4. Curriculum Evaluation

Evaluation is a modern concept of the traditional examination or assessment. Whereas, the old system is concerned with the results only, the evaluation is concerned of the results with reference to the aims and objectives.

It also attempts to find out whether goals, objectives and contents are balanced in the curriculum.

5. Curriculum is a Broad and Comprehensive Process

Curriculum is much more than class room instructions or syllabus. All the experiences provided by the institution come under curriculum.

Curriculum Development

Curriculum Development is a complex undertaking that involves many kinds of decisions. Decisions need to be made about the general aims which the educational institutions are to pursue and also about the more specific objectives of instructions.

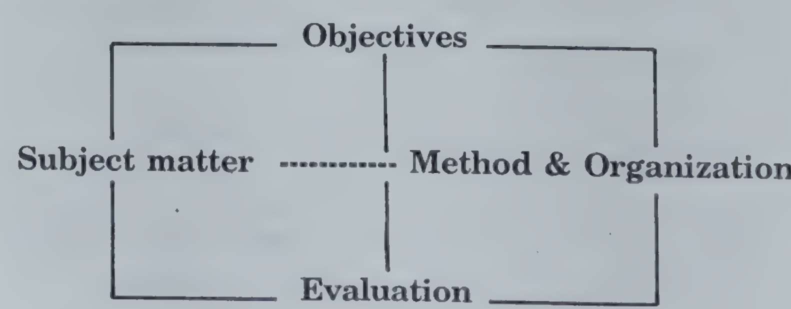
The major areas of curriculum must be selected as well as the specific contents to be covered in each discipline. Choices must be made about the learning experiences with what to implement, both content understanding, and other objectives.

Decisions are needed regarding how to evaluate what the students are learning and the effectiveness of the curriculum in attaining the desired ends and finally a choice needs to be made regarding what the overall pattern of the curriculum is to be (task oriented or subject oriented, competency based, etc.). These decisions which are made at different levels e.g. District, State, Centre, etc., help in curriculum development.

As curriculum is a plan of educational activities, selection and organization of contents, teaching patterns and evaluation methodology form the essential part of curriculum development. This will be done after assessing the training needs of the participants.

Curriculum is a dynamic subject. Provisions for changes from time to time are to be made depending upon the changing social and health needs. Major areas for curriculum will have to be identified so also the specific contents under each discipline.

CURRICULUM ELEMENTS



The planning and development of curriculum constitute an ongoing process. **Objectives** of the training activity should be reflected in the subject matter selected for the course. After analysing various training methods and selecting appropriate tools for training, the subject matter should be correctly fitted into the curriculum. An in-built system for evaluation of the curriculum is necessary so as to make appropriate modifications after each training course.

Evaluation of the curriculum includes the achievement of objectives, effectiveness of the training methods and the effects of training on the learning experiences and task performance of the trainees.

TEACHING AND LEARNING AIDS

These include audio-visual aids and simulators. The **core faculty and the trainers** need to be familiarised about the advantages and limitations of different teaching aids. They should be trained to operate the equipment (i.e. the overhead projectors, slide projectors, etc.). The trainers should select appropriate equipment according to the topic and the needs of the trainees. They should be well taught about the principles involved in the preparation of good training material for A.V. aids.

With more and more computerization on the anvil, satellite linked monitoring through modem and E-mail will soon be introduced into the training programmes.

Material for Audio - Visual Aids

While selecting and utilising different audio-visual aids, care should be taken to attain optimal effectiveness. The size of the letters should be properly planned as per the distance between the viewer and screen.

1. Non-Projected Material

Maximum viewing distance	Minimum height of letter
8 feet	1/4"
16 feet	1/2"
32 feet	1"
64 feet	2"

2. Charts and 35 mm Slides for Projector

Advantages :

- Suitable for small and large audience.

- Preparation of slides is very easy and not so expensive.

- Slide sets and projectors are light to carry.

- For projection no specific technical knowledge or skill is necessary.

Limitations :

- For front projection, darkening of the auditorium or classroom is necessary.

- Amount of information in one slide (in number of lines of matter) is limited.

- Uninterrupted electricity supply is needed.

Application :

- Useful for teaching in class rooms and self study units.

- Can be made use of repeatedly.

- With automatic projectors, slides can be changed, can be programmed, also advanced or reversed.

- Using a trans-focuser lens one can focus the details by remote control.

- Using a special light pointer one can pinpoint the details.

For maximum effectiveness of 35 mm slides, the following norms may be followed :

Title	- five words or less
Major ideas	- one to a slide
Lay out	- simple and open (plenty of white space)
Message	- seven lines or less

Words per line	- seven or less
Size of format	- height : width = 2 : 3
Printing of letters	- large enough to be read in the last row (check in the semi-lighted auditorium), chart of 50 cm height, letter should be 1 cm height.

3. Chalk Board

Advantages :

- Convenient to list items, draw charts, to solve problems.

- Inexpensive, can be made locally and easily cleaned.

- Usable for wide range of graphic representation.

- Allows, step by step build up, organisation of structure or concept.

- Helps student in taking notes.

Limitations :

- While writing, the back of the writer is directed towards the audience.

- Can be seen only by small group.

- Careful drawings erased, not preserved for future use.

- Considerable skill required for effective use.

- Difficult to move from place to place.

Application :

- Do not crowd the chalk board - a few points make a vivid impression.

- Make the material simple.

- Plan the presentation earlier.

4. Flannelographs

These are cut-outs used for visual publicity and demonstration, where the subject is presented in brief sentences and symbols.

Advantages :

- Can be used for instruction of groups and small audiences.

- Are most suitable for explanation of a subject step by step.

- Can be used repeatedly and immediately.

- Can be prepared very easily from locally available resources.

- Good for showing changing relationships.

- Holds attention, if used well.

Limitations :

- Can be used only for a small audience.

- Large cut-outs and cards are difficult to handle and store.

Application :

- Should be displayed at a place visible to the whole group.

- Use several simple cut-outs than a complex one and limit each visual to one message.

- Use colour cut-outs for better attention and emphasis.

- Plan your arrangement of cut-outs and symbols for proper sequence.

5. Overhead Projector

Advantages :

- Projectable in day light to audience, darkening of the class room is not needed.

- The image can be projected high on the screen or wall enabling whole class to see it clearly.

- Presented while the teacher is facing the audience.

- Relatively easy to prepare with local materials.

- It is easy to handle (not much technical skill needed).

Limitations :

- Overhead projector use for very large audience is limited.

- Equipments and material for making sophisticated transparencies are expensive.

- Uninterrupted power supply is required.

Application :

- Use several simple transparencies rather than one complex one and limit each visual to one message.

- Use for writing of transparencies, chemical pencil (overhead projection pencil or wax crayon).

- Use colour transparencies for better attention and to emphasize details.

- Use for many time projection transparencies prepared by thermofax.

6. Use of Variety of Techniques

Build-up technique : overlay or selective revealing.

Highlighting : to focus a point.

Animation : movement of parts.

7. Preparation of Transparency

a. Free hand

b. Transfer lettering

c. Reprographic - thermal, Xerox.

8. Tapes and Tape-recorders

Advantages :

- Adoptable to any teaching of learning situation and to any size of audience.

- Very useful for individual or small group learning, micro-teaching.

- Easy to operate with cassettes.

- Easy to prepare many copies.

Limitations :

- Good quality of recording can be achieved only with studio facilities.

- For individual learning many playback units required.

- For big size of audience an amplifier is necessary.

Application :

- Use for providing narrations for slide sequences.

- Use for comment to the silent film and filmstrips and film loops.

- Use for micro-teaching and problem solving methods.

- Use for introduction to specific explanation for manipulation of equipment.

- Uninterrupted power supply is needed.

9. Closed Circuit Television (CCTV) System

Advantages :

- Useful for small and large groups and class rooms (depends on the number of monitors or projection system).

- Very efficient in transmitting an action where only one or limited persons can participate (e.g. microscopy).

- Using a video recorder, it is possible to record picture or action and immediate playback.

- Playback of the same picture or action is possible many times.

- Television programmes on the video-tape could be improved later if necessary or erased.

- Video-tape programmes permit the use of a combination of films, slides or other media.

Limitations :

- C.C.T.V. equipment is very costly.

- Special technical staff is required.

- Uninterrupted power supply is required.

Application :

- Use for evaluation of a particular teaching plan.

- The teacher can see as others see him.

- Useful for self instruction by means of video tapes.

COMPUTERS FOR TRAINING

Role of Computers in Training Programmes:

Present day computers provide various interactive programmes which provide information to the learner in a dynamic manner. A variety of roles/ modes are possible with computer assisted learning, giving much flexibility in imparting training.

Drill and Practice Mode:

Here, the learner can learn facts and memorise them by drill-method; or use an MCQ bank for practice. This mode is used in remedial education programmes for slow-learners.

Tutorial Mode:

Here, a well structured programmed learning unit (or CAL module) provides interactive learning. This mode, if used well, could result in 90% retention of the content (compared to 30% retention after the best lecture). In Tutorial Mode, a module (lesson) consists of :

a. Presentation of content in a structured way

b. Task - prescription to elicit learner's response and

c. Instant feedback and reinforcement to the learner.

Laboratory Mode:

Computer could be programmed to simulate a variety of biological processes to supplement or do away with laboratory experiments. The learner explores various options and learns by inference.

Case-Simulation Mode:

A variety of diagnostic and therapeutic problems of the patient management type could be effectively computerised. This has proved quite useful in learning problem solving, the highest cognitive domain.

Consultant Mode:

It is one of the frontier areas now.

Expert programmes have been devised using Artificial Intelligence (AI). These could bring the expertise of a consultant within easy reach of a health worker at the periphery.

Manager of Educational Process:

Computer based Management Information System (MIS) could keep track of student's performance and offer suitable advice to make the process more effective.

Computer Assisted Learning (CAL) :

Training in control of malaria and other vector-borne diseases in future will have CAL as an important component. This method of imparting training is being used currently in medical and health fields. Although the computer cannot replace a teacher, this method of CAL complements teacher's role.

In some areas of interaction, it is definitely better than the human teacher, as :

- it never gets tired

- it does not commit mistakes on its own

- it permits individual attention

- the learner can decide his/her own pace of learning. Some of the roles the CAL can play are:

- tutorial mode
- laboratory mode
- case simulation mode
- consultant role

The main objectives of utilising CAL are **i**) to make the participants aware of the immense potential of computers in the health care delivery system as well as Health Management Information System and **ii**) to make use of the CAL in vital areas of training, e.g. Health Education.

Facilities for providing hands-on training to the trainees will be initiated and extended to various levels of training infrastructure in phases. Emphasis will be made for procuring/developing tutor modes, laboratory modes and case-simulation modes for this purpose.

Some of the software programmes like "Epi Info" (version 6) are found to be very useful for training the health workers for all health programmes including control of malaria. These software have in-built tutorial.

Training Environment:

It should be congenial to learning. Steps should be taken from the first day of the training programme to encourage each participant to interact actively and status differentials of the trainees should be overcome so as to achieve their active participation. Practical sessions and demonstrations should dominate the training curricula.

Equipment for Training

should be procured after careful planning of the training facilities, training environment and the ability of the trainers to utilise them properly. The core faculty and other trainers should be exposed to the teaching processes and principles, in addition to the teaching methodologies.

The faculty should also be trained in organising **group learning activities** as part of the training sessions. Various methods related to group discussions like controlled discussions, free group discussions, buzz-groups, brain storming, seminars, etc. should be familiar to the core faculty as well as other trainers.

The Directorate of National Malaria Eradication Programme is planning to procure the latest available audio-visual equipment to effectively improve and reinforce its training requirements. Video-taping of the training sessions and short presentations will help the organization to get a feedback on its own performance and problems related to performance can be identified.

EVALUATION

Evaluation of the training should consist of four main aspects. These include evaluation of :

i. Training course

ii. Trainee

iii. Trainer

iv. Training material

Evaluation should both be immediate and long-term. The ultimate objective of evaluation is constant review thereby permitting necessary modifications to the training course.

Evaluation of Lecture Effectiveness

This should be undertaken through :

i. Informal feedback in the class

ii. Formal student evaluation

iii. Peer evaluation

iv. Examination of the students after the lecture

v. Feedback by video/audio recording.

Evaluation of Training Effectiveness

Assessment of training effectiveness is an important component of the training programmes. The programme is planning to design modules / formats for this purpose. A checklist will be prepared for every training organization at Central as well as peripheral levels to evaluate their training programmes.

DISTANCE LEARNING PROGRAMME

As a large number of health functionaries are to be trained, it may not be possible to organise training courses for all the persons involved in malaria control at one point of time and it may involve long procedures consuming a lot of time.

A programme through distance learning with the help of satellite is envisaged at the Central level from where all modalities/procedures including syllabus and curriculum as per the requirements of peripheral medical and paramedical personnel need to be laid down.

Issue of the 'Operational Guidelines' is one of the methods of distance learning recommended for field workers under National Malaria Eradication Programme.

ESTIMATED TRAINING NEEDS OF NATIONAL MALARIA ERADICATION PROGRAMME AT VARIOUS LEVELS OF HEALTH CARE DELIVERY SYSTEM

The estimated training needs of the target groups of various categories of personnel under the national health programmes with particular reference to vector control programme are given below:-

1. The Programme is reviving the concepts of Fever Treatment Depots (FTDs) and Drug Distribution Centres (DDCs) to achieve Early Case Diagnosis and Prompt Treatment (EDPT) as part of Global Malaria Control Strategy. In addition, a "Link Worker" hailing from the local community is to be deployed in high risk areas.

It is estimated that about 7,50,000 workers are to be imparted one-day training in the respective Primary Health Centres on the basic aspects of community participation in insecticidal spray operations, blood smear collection from fever cases, compliance for full course of malaria treatment and personal protection measures.

Each batch may comprise of 30 trainees and 25,000 such batches are expected to be trained over a period of five years.

2. Multipurpose Health Workers (MPWs) require professional skills in IEC, supervision in the indoor residual spray operations, detection and treatment of malaria cases promptly, referral of complicated cases and keeping vigil on treatment failures.

It is planned to impart 'two-day' training at the respective PHCs on the requisite skills. There are 1,50,000 MPWs in the country. Each batch of trainees may comprise of 25 MPWs and 6,000 batches in five years @ 1,200 batches per year are proposed to be trained.

3. One supervisor earmarked for malaria control activities in each of the PHCs is to be trained for two weeks on the planning, implementation, concurrent and consecutive supervision of insecticidal spray operations, detection and treatment of malaria cases, logistics, evaluation, etc. at one of the training centres such as Regional Offices for Health and Family Welfare (ROH & FW), Regional Family Welfare Training Centres (RFWTC), Central Malaria Laboratories (CML), Zonal Training Centres, etc.

In total 1,000 batches in five years @ 200 batches per year and each batch having 25 participants have been proposed for training.

4. One Laboratory technician involved in malaria work in each Primary Health Centre will be imparted four weeks practical training on blood smear collection, processing, staining, stain preparation, differential diagnosis, record keeping, etc. at well equipped training centres.

In total 1,000 batches in five years @ 200 batches per year and each batch having 25 trainees are to be imparted training.

5. Medical Officer (MO) of Primary Health Centre holds a pivotal role in the implementation of the programme. In the decentralised strategy the MO is responsible and accountable for proper implementation and monitoring of the programme. He is to be acquainted with the role and responsibilities in the supervision of early diagnosis and treatment, vector control measures, intersectoral coordination, community participation, training of grassroots level workers, etc.

It has been proposed to impart 'five day'

training at one of the training centres. In all 1,000 batches in five years @ 200 batches per year are to be trained and each batch will have an average of about 25 participants.

6. The district officers are to plan, manage, monitor and evaluate the programme in the entire district. They should be well conversant with the principles of planning, modern management techniques, inter-sectoral coordination, IEC, MIS, Epidemiology and field operational research.

It is proposed to impart 'four week' training to four officials in each district at premier institutions like the National Institute of Communicable Diseases, Malaria Research Centre and other training centres under Indian Council of Medical Research, Institute of Vector Control and Zoonoses, Hosur (Tamil Nadu) and some selected medical colleges and bio-medical research institutions. In total 1875 officials are to be trained in 75 batches in five years @ 15 batches per year.

7. Zonal Entomologists/Biologists have to perform very specialised duties in their respective fields. There are about 500 professionals under these cadres in the country. They will be imparted training similar to district level officers but special emphasis will be given on entomological techniques, dynamics of transmission, etc. The training will be for four weeks. Every year four batches will be trained.

8. The trainers in the training institutes need to be acquainted with the basic tenets of pedagogy. They should update their knowledge and skills through continuous education and exposure. It may neither be feasible to employ large number of faculty specially for training alone nor possible to develop versatile expertise among the limited members of permanent faculty at the training centres.

It is prudent to supplement the training needs by deploying guest faculty possessing expertise in the specialised fields from outside the programme. It is very advantageous to locate the training centres near medical colleges/research institutions/ other training institutions to arrange guest lecturers.

It is proposed to hold two trainers' training workshops for five day duration at NICD/NMEP to train 50 to 60 trainers every year.

9. Training and education on vector-borne diseases and the bio-environmental control measures shall be imparted to engineers, and other officers in-charge of developmental projects, public works, irrigation, water resources, forestry, environment, fisheries, railways, agriculture, mining, communications, etc. through specially designed workshops, brochures and manuals.

It is proposed to hold one workshop every year in bigger States and one workshop in five years in smaller States/Union Territories. The workshops shall be for three days with the second day for field visit to developmental project areas to study mosquitogenic conditions and undertaking naturalistic or integrated methods of vector control.

A few workshops have already been conducted by the Directorate of NMEP in Maharashtra, Karnataka, Gujarat, Rajasthan and Uttar Pradesh. The outcome of these workshops has been very encouraging. Twenty workshops are proposed to be conducted every year.

10. The basic prerequisites of a training centre are the location of the centre in an ideal environment with infrastructure facilities like adequate space, ideal class room fitted with modern teaching aids, well equipped laboratory, insectary, animal house for experimental malaria, computers for information storage and retrieval, library with full spectrum of books, periodicals and scientific journals on malaria and other vector borne diseases, adequate transport facility for field visits, a good hostel for boarding and lodging for participants and visiting faculty and above all a highly proficient team of trained teachers.

Operational Research should be an integral part of the training centres to gain firsthand information on different aspects of malaria and other vector-borne diseases, to evaluate skills through experimentation and also to record any change in the approach that may be warranted from time to time.

The research activities confer unique opportunities to augment the technical skills of trainers who in turn transmit the same to trainees. The technical problems faced by the field staff could be taken up by the training centres to arrive at solutions. The Operational Research should include feasibility studies on alternative methods of control, different diagnostic techniques, screening methods, chemotherapeutic trials, evaluation techniques, IEC activities for community participation, cost-effectiveness analysis, human behaviouristic patterns, etc.

11. The training curriculum differs for different categories of field staff according to their role and responsibilities. The topics need to be updated due to periodic changes made in the strategy of control on account of rapid technological developments. The curriculum for the top echelons should include subjects inculcating sound knowledge and perception of the programme, latest knowledge on different control methodologies, biology of vectors as well as parasite, etc.

The curriculum should be balanced properly for each tier of workers covering vast array of instructional material and methods through lecture-discussions, practical-demonstrations, field exercises, films, slides, charts, models, books, programmed lecture notes, group and panel discussions. The stereotyped notes and monotonous lectures are to be replaced by the upgraded and utility methods. The skills produced once are to be constantly updated through continuous interaction between the trained workers and training institutions

10

EPIDEMIOLOGICAL DATA : DISTRICTWISE AND STATEWISE

Prior to the launching of National Malaria Control Programme in 1953, the incidence of malaria was estimated to be about 75 million cases annually with about 0.8 million deaths in the country. Through concerted efforts and series of containment measures undertaken throughout the country after launching of National Malaria Eradication Programme, the incidence was brought down to 0.1 million with no deaths by 1965. Thereafter, there was gradual and consistent increase in malaria cases reaching the peak of 6.47 million in 1976. The rapid escalation in malaria incidence necessitated major changes in the concept and priorities in the programme through introduction of Modified Plan of Operation.

From 1983 onwards the total malaria cases in the country were around two million per annum touching the lowest incidence of 1.66 million in 1987 and the peak of 2.51 million in 1993. The proportion of *P.falciparum* showed gradual and consistent increase from 9.73 per cent in 1977 to 34.50 per cent in 1995 with the peak reaching 43.3 per cent in 1991.

During 1993 six States namely Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Orissa and Rajasthan contributed 61.5 per cent of total malaria cases and 73.6 per cent of *P.falciparum* cases recorded in the country and the same were 62.1 per cent and 73.6 per cent during 1994 and 59.2 per cent and 69.1 per cent during 1995 respectively. Orissa contributed nearly 30 per cent of *P.falciparum* cases in the country during the last three years.

Of the remaining States in India, Assam, Arunachal Pradesh, Karnataka, Meghalaya, Mizoram and Tamil Nadu together contributed 25.1 per cent of total malaria cases and 23.0 per cent of *P.falciparum* cases during 1995 in the country. Thus these 12 States together contributed 84.3 per cent total malaria cases and 92.0 per cent of *P.falciparum* cases reported in the country during 1995.

After launching of NMEP, the deaths due to malaria were first recorded during 1974 and the peak of 1122 deaths reached in 1994 due to epidemics in Rajasthan, Manipur and Nagaland. The deaths recorded due to malaria were also high reaching the figure of 1012 during 1995.

During the last two decades Orissa recorded 1641 deaths due to malaria contributing 25.5 per cent of deaths reported in the country followed by 15.1 per cent in Assam, and 9.9 per cent in Rajasthan. Thus these three States contributed more than half of the deaths recorded in the

country during the last two decades. No deaths due to malaria were reported from Himachal Pradesh, Jammu & Kashmir, Goa, Dadra & Nagar Haveli, Daman & Diu, Lakshadweep and Pondicherry ever since the launching of NMEP in the country.

The seven North Eastern States namely Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Tripura recorded 8.3 to 12.3 per cent of total positives and 12.12 20.2 per cent of *P.falciparum* cases during the last three years in the country.

The Districtwise Epidemiological Data are given in this Chapter from 1985 to 1995 in alphabetical order of States and Union Territories. The Statewise Epidemiological Data and the overall data for the country are given from 1961 to 1995. The Data of some years especially for 1985 and 1995 were not available at the time of printing of this book and hence the relevant columns have been kept blank so that the reader could fill the blanks whenever he will have access to such data in future.

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Srikakulam

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	1917	273091	965	662	303	68.60	14.25	0.50	0.35	0.24	0
1986	1917	187767	784	534	250	68.11	9.79	0.41	0.42	0.28	0
1987	1931	269539	1117	758	359	67.86	13.96	0.58	0.41	0.28	0
1988	1955	262345	1858	1027	831	55.27	13.42	0.95	0.71	0.39	0
1989	1998	274948	2234	1808	426	80.93	13.76	1.12	0.81	0.66	0
1990	1998	242027	2059	1644	415	79.84	12.17	1.03	0.85	0.68	0
1991	2047	267125	2882	2349	533	81.51	13.05	1.41	1.08	0.88	0
1992	2117	272034	4722	3465	1257	73.38	12.85	2.23	1.74	1.27	0
1993	2168	286636	4887	3694	1193	75.59	13.22	2.25	1.70	1.29	0
1994	2183	308295	4712	3520	1192	74.70	14.12	2.16	1.53	1.14	2
1995(P)	2228	289644	5241	4413	828	84.20	13.00	2.35	1.81	1.52	0

2. District : Vizianagaram

1985	1810	240527	1947	1059	888	54.39	13.29	1.08	0.81	0.44	0
1986	1810	188567	1445	1141	304	78.96	10.42	0.80	0.77	0.61	0
1987	1810	250037	2613	2202	411	84.27	13.81	1.44	1.05	0.88	0
1988	1720	250278	2125	1733	392	81.55	14.55	1.24	0.85	0.69	0
1989	1720	275138	3088	2771	317	89.73	16.00	1.80	1.12	1.01	0
1990	1720	286878	1469	1277	192	86.93	16.68	0.85	0.51	0.45	0
1991	1732	344774	1830	1689	141	92.30	19.91	1.06	0.53	0.49	0
1992	1767	343876	2199	1716	483	78.04	19.46	1.24	0.64	0.50	0
1993	1810	330556	1860	1440	420	77.42	18.26	1.03	0.56	0.44	0
1994	1828	337823	2287	1636	651	71.53	18.48	1.25	0.68	0.48	0
1995 (P)	1866	320459	3267	2666	601	81.60	17.17	1.75	1.02	0.83	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Visakhapatnam

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2522	361225	4451	2689	1762	60.41	14.32	1.76	1.23	0.74	0
1986	2527	243787	3173	1588	1585	50.05	9.65	1.26	1.30	0.65	0
1987	2527	334638	5014	2708	2306	54.01	13.24	1.98	1.50	0.81	0
1988	2527	369529	7028	3142	3886	44.71	14.62	2.78	1.90	0.85	0
1989	2609	496864	19339	9422	9917	54.34	19.04	7.41	3.89	1.90	0
1990	2730	432625	10749	4926	5823	45.83	15.85	3.94	2.48	1.14	0
1991	2946	503403	17938	8088	9850	45.09	17.09	6.09	3.56	1.61	0
1992	2946	627980	26724	7349	19375	27.50	21.32	9.07	4.26	1.17	0
1993	2946	565789	34567	6599	27968	19.09	19.21	11.73	6.11	1.17	0
1994	3024	632327	36241	9520	26721	26.27	20.91	11.98	5.73	1.51	0
1995(P)	3087	566363	24408	7864	16544	32.22	18.65	7.91	4.31	1.39	0

4. District : East Godavari

1985	3702	579182	3641	3011	630	82.70	15.65	0.98	0.63	0.52	0
1986	3702	432521	2271	1834	437	80.76	11.68	0.61	0.53	0.42	0
1987	3702	514901	4549	4173	376	91.73	13.91	1.23	0.88	0.81	0
1988	3702	513782	3987	3387	600	84.95	13.88	1.08	0.78	0.66	0
1989	3482	481570	4884	4547	337	93.10	13.83	1.40	1.01	0.94	0
1990	3482	456800	7102	6371	731	89.71	13.12	2.04	1.55	1.39	0
1991	3584	481582	5085	4561	524	89.70	13.44	1.42	1.06	0.95	0
1992	3584	489125	3993	3570	423	89.41	13.65	1.11	0.82	0.73	0
1993	3584	461940	4259	3840	419	90.16	12.89	1.19	0.92	0.83	0
1994	3643	498954	6883	6242	641	90.69	13.70	1.89	1.38	1.25	0
1995(P)	3719	470382	5886	5130	756	87.16	12.65	1.58	1.25	1.09	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : West Godavari

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2857	349758	619	487	132	78.68	12.24	0.22	0.18	0.14	0
1986	2857	245567	420	314	106	74.76	8.60	0.15	0.17	0.13	0
1987	2857	306458	397	278	119	70.03	10.73	0.14	0.13	0.09	0
1988	2857	379733	198	164	34	82.83	13.29	0.07	0.05	0.04	0
1989	2857	371206	598	435	163	72.74	12.99	0.21	0.16	0.12	0
1990	2893	413444	4311	3347	964	77.64	14.29	1.49	1.04	0.81	0
1991	2903	442700	2196	1751	445	79.74	15.25	0.76	0.50	0.40	0
1992	2980	426424	655	496	159	75.73	14.31	0.22	0.15	0.12	0
1993	3022	436067	312	185	127	59.29	14.43	0.10	0.07	0.04	0
1994	3045	418775	262	185	77	70.61	13.75	0.09	0.06	0.04	0
1995(P)	3108	378423	246	169	77	68.70	12.18	0.08	0.07	0.04	0

6. District : Krishna

1985	3042	383323	4497	11	4486	0.24	12.60	1.48	1.17	0.00	0
1986	3042	267891	3168	12	3156	0.38	8.81	1.04	1.18	0.00	0
1987	3042	364223	2909	48	2861	1.65	11.97	0.96	0.80	0.01	0
1988	3050	464774	4227	256	3971	6.06	15.24	1.39	0.91	0.06	0
1989	3085	433431	4006	120	3886	3.00	14.05	1.30	0.92	0.03	0
1990	3085	478140	8844	55	8789	0.62	15.50	2.87	1.85	0.01	0
1991	3157	482718	8971	53	8918	0.59	15.29	2.84	1.86	0.01	0
1992	3157	488429	10490	60	10430	0.57	15.47	3.32	2.15	0.01	0
1993	3383	471503	10373	100	10273	0.96	13.94	3.07	2.20	0.02	0
1994	3417	436293	11929	269	11660	2.26	12.77	3.49	2.73	0.06	0
1995(P)	3488	417089	17962	858	17104	4.78	11.96	5.15	4.31	0.21	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Guntur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	3427	480996	2416	54	2362	2.24	14.04	0.70	0.50	0.01	0
1986	3248	384048	2948	124	2824	4.21	11.82	0.91	0.77	0.03	0
1987	3927	464468	3022	277	2745	9.17	11.83	0.77	0.65	0.06	0
1988	4021	519919	4367	510	3857	11.68	12.93	1.09	0.84	0.10	0
1989	4098	387574	4425	195	4230	4.41	9.46	1.08	1.14	0.05	0
1990	4166	371930	6386	279	6107	4.37	8.93	1.53	1.72	0.08	0
1991	4250	462362	6357	593	5764	9.33	10.88	1.50	1.37	0.13	0
1992	4250	490175	4128	419	3709	10.15	11.53	0.97	0.84	0.09	0
1993	4275	576107	5409	1179	4230	21.80	13.48	1.27	0.94	0.20	0
1994	4228	581650	4091	864	3227	21.12	13.76	0.97	0.70	0.15	0
1995(P)	4316	540299	3156	778	2378	24.65	12.52	0.73	0.58	0.14	0

8. District :Prakasam

1985	2456	312055	1354	359	995	26.51	12.71	0.55	0.43	0.12	0
1986	2457	200396	358	52	306	14.53	8.16	0.15	0.18	0.03	0
1987	2600	312487	544	129	415	23.71	12.02	0.21	0.17	0.04	0
1988	2600	339936	550	118	432	21.45	13.07	0.21	0.16	0.03	0
1989	2890	337832	557	151	406	27.11	11.69	0.19	0.16	0.04	0
1990	2890	293205	511	200	311	39.14	10.15	0.18	0.17	0.07	0
1991	2517	300111	670	339	331	50.60	11.92	0.27	0.22	0.11	0
1992	2753	286791	723	398	325	55.04	10.42	0.26	0.25	0.14	0
1993	2753	298126	927	363	564	39.16	10.83	0.34	0.31	0.12	0
1994	2900	802725	1185	269	916	22.70	27.68	0.41	0.15	0.03	0
1995(P)	2960	272451	3253	1320	1933	40.58	9.20	1.10	1.19	0.48	0

9. District : Nellore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2006	281774	337	36	301	10.68	14.05	0.17	0.12	0.01	0
1986	2360	216755	79	3	76	3.80	9.18	0.03	0.04	0.00	0
1987	2360	256819	47	1	46	2.13	10.88	0.02	0.02	0.00	0
1988	2360	265796	65	10	55	15.38	11.26	0.03	0.02	0.00	0
1989	2360	222766	60	4	56	6.67	9.44	0.03	0.03	0.00	0
1990	2360	219750	203	3	200	1.48	9.31	0.09	0.09	0.00	0
1991	2360	213423	31	0	31	0.00	9.04	0.01	0.01	0.00	0
1992	2388	194847	186	7	179	3.76	8.16	0.08	0.10	0.00	0
1993	2388	199282	84	11	73	13.10	8.35	0.04	0.04	0.01	0
1994	2589	183057	136	14	122	10.29	7.07	0.05	0.07	0.01	0
1995(P)											

10. District : Chittoor

1985	2747	438133	748	347	401	46.39	15.95	0.27	0.17	0.08	0
1986	2747	318530	291	111	180	38.14	11.60	0.11	0.09	0.03	0
1987	2747	364404	404	258	146	63.86	13.27	0.15	0.11	0.07	0
1988	2779	343686	1144	820	324	71.68	12.37	0.41	0.33	0.24	0
1989	2779	374850	2370	654	1716	27.59	13.49	0.85	0.63	0.17	0
1990	2831	423821	936	149	787	15.92	14.97	0.33	0.22	0.04	0
1991	2879	485992	182	14	168	7.69	16.88	0.06	0.04	0.00	0
1992	2939	483449	140	17	123	12.14	16.45	0.05	0.03	0.00	0
1993	2996	491242	149	19	130	12.75	16.40	0.05	0.03	0.00	0
1994	3059	493692	102	4	98	3.92	16.14	0.03	0.02	0.00	0
1995(P)	2643	170582	223	34	189	15.25	6.45	0.08	0.13	0.02	0

7. District : Guntur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	3427	480996	2416	54	2362	2.24	14.04	0.70	0.50	0.01	0
1986	3248	384048	2948	124	2824	4.21	11.82	0.91	0.77	0.03	0
1987	3927	464468	3022	277	2745	9.17	11.83	0.77	0.65	0.06	0
1988	4021	519919	4367	510	3857	11.68	12.93	1.09	0.84	0.10	0
1989	4098	387574	4425	195	4230	4.41	9.46	1.08	1.14	0.05	0
1990	4166	371930	6386	279	6107	4.37	8.93	1.53	1.72	0.08	0
1991	4250	462362	6357	593	5764	9.33	10.88	1.50	1.37	0.13	0
1992	4250	490175	4128	419	3709	10.15	11.53	0.97	0.84	0.09	0
1993	4275	576107	5409	1179	4230	21.80	13.48	1.27	0.94	0.20	0
1994	4228	581650	4091	864	3227	21.12	13.76	0.97	0.70	0.15	0
1995(P)	4316	540299	3156	778	2378	24.65	12.52	0.73	0.58	0.14	0

8. District :Prakasam

1985	2456	312055	1354	359	995	26.51	12.71	0.55	0.43	0.12	0
1986	2457	200396	358	52	306	14.53	8.16	0.15	0.18	0.03	0
1987	2600	312487	544	129	415	23.71	12.02	0.21	0.17	0.04	0
1988	2600	339936	550	118	432	21.45	13.07	0.21	0.16	0.03	0
1989	2890	337832	557	151	406	27.11	11.69	0.19	0.16	0.04	0
1990	2890	293205	511	200	311	39.14	10.15	0.18	0.17	0.07	0
1991	2517	300111	670	339	331	50.60	11.92	0.27	0.22	0.11	0
1992	2753	286791	723	398	325	55.04	10.42	0.26	0.25	0.14	0
1993	2753	298126	927	363	564	39.16	10.83	0.34	0.31	0.12	0
1994	2900	802725	1185	269	916	22.70	27.68	0.41	0.15	0.03	0
1995(P)	2960	272451	3253	1320	1933	40.58	9.20	1.10	1.19	0.48	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : Nellore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2006	281774	337	36	301	10.68	14.05	0.17	0.12	0.01	0
1986	2360	216755	79	3	76	3.80	9.18	0.03	0.04	0.00	0
1987	2360	256819	47	1	46	2.13	10.88	0.02	0.02	0.00	0
1988	2360	265796	65	10	55	15.38	11.26	0.03	0.02	0.00	0
1989	2360	222766	60	4	56	6.67	9.44	0.03	0.03	0.00	0
1990	2360	219750	203	3	200	1.48	9.31	0.09	0.09	0.00	0
1991	2360	213423	31	0	31	0.00	9.04	0.01	0.01	0.00	0
1992	2388	194847	186	7	179	3.76	8.16	0.08	0.10	0.00	0
1993	2388	199282	84	11	73	13.10	8.35	0.04	0.04	0.01	0
1994	2589	183057	136	14	122	10.29	7.07	0.05	0.07	0.01	0
1995(P)											

10. District : Chittoor

1985	2747	438133	748	347	401	46.39	15.95	0.27	0.17	0.08	0
1986	2747	318530	291	111	180	38.14	11.60	0.11	0.09	0.03	0
1987	2747	364404	404	258	146	63.86	13.27	0.15	0.11	0.07	0
1988	2779	343686	1144	820	324	71.68	12.37	0.41	0.33	0.24	0
1989	2779	374850	2370	654	1716	27.59	13.49	0.85	0.63	0.17	0
1990	2831	423821	936	149	787	15.92	14.97	0.33	0.22	0.04	0
1991	2879	485992	182	14	168	7.69	16.88	0.06	0.04	0.00	0
1992	2939	483449	140	17	123	12.14	16.45	0.05	0.03	0.00	0
1993	2996	491242	149	19	130	12.75	16.40	0.05	0.03	0.00	0
1994	3059	493692	102	4	98	3.92	16.14	0.03	0.02	0.00	0
1995(P)	2643	170582	223	34	189	15.25	6.45	0.08	0.13	0.02	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Cuddapah

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	1938	263048	761	158	603	20.76	13.57	0.39	0.29	0.06	0
1986	1938	204525	812	73	739	8.99	10.55	0.42	0.40	0.04	0
1987	1938	250951	881	267	614	30.31	12.95	0.45	0.35	0.11	0
1988	1928	266078	2489	740	1749	29.73	13.80	1.29	0.94	0.28	0
1989	2028	247078	3817	936	2881	24.52	12.18	1.88	1.54	0.38	0
1990	2028	248752	3204	761	2443	23.75	12.27	1.58	1.29	0.31	0
1991	2028	241666	1039	271	768	26.08	11.92	0.51	0.43	0.11	0
1992	2028	246158	1372	500	872	35.64	12.14	0.68	0.56	0.20	0
1993	2028	295475	1660	433	1227	26.08	14.57	0.82	0.56	0.15	0
1994	2460	327065	1002	423	579	40.62	13.30	0.41	0.31	0.13	0
1995(P)	2511	303502	3166	1648	1518	52.05	12.09	1.26	1.04	0.54	0

12. District : Ananthapur

1985	2618	428017	2224	726	1498	32.64	16.35	0.85	0.52	0.17	0
1986	2760	358410	1391	278	1113	19.99	12.99	0.50	0.39	0.08	0
1987	2820	418985	2639	923	1716	34.98	14.86	0.94	0.63	0.22	0
1988	2820	463754	2704	972	1732	35.95	16.45	0.96	0.58	0.21	0
1989	2820	476361	5373	2300	3073	42.81	16.89	1.91	1.13	0.48	0
1990	2820	460072	8457	2228	6229	26.35	16.31	3.00	1.84	0.48	0
1991	3184	401367	2798	513	2285	18.33	12.61	0.88	0.70	0.13	0
1992	3184	414170	5521	1369	4152	24.80	13.01	1.73	1.33	0.33	0
1993	3184	462530	2736	829	1907	30.30	14.53	0.86	0.59	0.18	0
1994	3184	444142	1741	442	1299	25.38	13.95	0.55	0.39	0.10	0
1995(P)	3250	423562	2189	668	1521	30.52	13.03	0.67	0.52	0.16	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

13. District : Kurnool

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2414	421722	1885	522	1363	27.69	17.47	0.78	0.45	0.12	0
1986	2414	286213	1074	210	864	19.55	11.86	0.44	0.38	0.07	0
1987	2638	326192	1572	334	1238	21.25	12.37	0.60	0.48	0.10	0
1988	2687	314169	2006	360	1646	17.95	11.69	0.75	0.64	0.11	0
1989	2781	326169	3432	733	2699	21.36	11.73	1.23	1.05	0.22	0
1990	2645	317606	4230	961	3269	22.72	12.01	1.60	1.33	0.30	0
1991	2917	366676	3154	525	2629	16.65	12.57	1.08	0.86	0.14	0
1992	2965	366554	3792	489	3303	12.90	12.36	1.28	1.03	0.13	0
1993	2965	354148	3073	490	2583	15.95	11.94	1.04	0.87	0.14	0
1994	2418	316614	2196	303	1893	13.80	13.09	0.91	0.69	0.10	0
1995(p)	2468	312041	4032	1472	2560	36.51	12.64	1.63	1.29	0.47	0

14. District : Mehabub Nagar

1985	2446	311239	489	149	340	30.47	12.72	0.20	0.16	0.05	0
1986	2447	290837	402	155	247	38.56	11.89	0.16	0.14	0.05	0
1987	2637	312348	379	117	262	30.87	11.84	0.14	0.12	0.04	0
1988	2637	326404	618	206	412	33.33	12.38	0.23	0.19	0.06	0
1989	2637	274271	406	173	233	42.61	10.40	0.15	0.15	0.06	0
1990	2637	294692	449	134	315	29.84	11.18	0.17	0.15	0.05	0
1991	2637	272240	480	152	328	31.67	10.32	0.18	0.18	0.06	0
1992	2637	289108	530	209	321	39.43	10.96	0.20	0.18	0.07	0
1993	2637	293593	224	125	99	55.80	11.13	0.08	0.08	0.04	0
1994	2694	310916	268	151	117	56.34	11.54	0.10	0.09	0.05	1
1995(P)	2750	280777	275	170	105	61.82	10.21	0.10	0.10	0.06	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

15. District : Medak

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	1827	211916	221	32	189	14.48	11.60	0.12	0.10	0.02	0
1986	2000	200800	124	14	110	11.29	10.04	0.06	0.06	0.01	0
1987	2039	212446	64	2	62	3.13	10.42	0.03	0.03	0.00	0
1988	2039	220323	206	42	164	20.39	10.81	0.10	0.09	0.02	0
1989	2039	184453	988	220	768	22.27	9.05	0.48	0.54	0.12	0
1990	2039	143402	429	51	378	11.89	7.03	0.21	0.30	0.04	0
1991	2039	143161	122	0	122	0.00	7.02	0.06	0.09	0.00	0
1992	2039	160214	39	0	39	0.00	7.86	0.02	0.02	0.00	0
1993	2039	204438	104	11	93	10.58	10.03	0.05	0.05	0.01	0
1994	2039	235987	85	12	73	14.12	11.57	0.04	0.04	0.01	0
1995(P)	2081	219821	36	6	30	16.67	10.56	0.02	0.02	0.00	0

16. District : Nalgonda

1985	2241	346300	94	1	93	1.06	15.45	0.04	0.03	0.00	0
1986	2275	278005	96	0	96	0.00	12.22	0.04	0.03	0.00	0
1987	2287	296663	146	0	146	0.00	12.97	0.06	0.05	0.00	0
1988	2287	271403	104	2	102	1.92	11.87	0.05	0.04	0.00	0
1989	2287	233845	59	1	58	1.69	10.22	0.03	0.03	0.00	0
1990	2287	328240	112	1	111	0.89	14.35	0.05	0.03	0.00	0
1991	2287	412471	102	1	101	0.98	18.04	0.04	0.02	0.00	0
1992	2849	389768	32	0	32	0.00	13.68	0.01	0.01	0.00	0
1993	2883	392694	34	0	34	0.00	13.62	0.01	0.01	0.00	0
1994	3036	397571	86	1	85	1.16	13.10	0.03	0.02	0.00	0
1995(P)	3099	345743	30	2	28	6.67	11.16	0.01	0.01	0.00	0

17. District : Hyderabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2250	258284	4099	156	3943	3.81	11.48	1.82	1.59	0.06	0
1986	2250	276686	3365	75	3290	2.23	12.30	1.50	1.22	0.03	0
1987	2250	303837	5058	110	4948	2.17	13.50	2.25	1.66	0.04	0
1988	3000	352524	8192	183	8009	2.23	11.75	2.73	2.32	0.05	0
1989	3000	354784	6603	204	6399	3.09	11.83	2.20	1.86	0.06	0
1990	3000	390097	5163	156	5007	3.02	13.00	1.72	1.32	0.04	0
1991	3126	413342	4138	122	4016	2.95	13.22	1.32	1.00	0.03	0
1992	3176	487877	3209	38	3171	1.18	15.36	1.01	0.66	0.01	0
1993	3276	483489	2290	108	2182	4.72	14.76	0.70	0.47	0.02	0
1994	3276	497374	1477	150	1327	10.16	15.18	0.45	0.30	0.03	6
1995(P)	3344	436719	1235	161	1074	13.04	13.06	0.37	0.28	0.04	0

18. District : Rangareddy

1985	1580	157606	146	13	133	8.90	9.98	0.09	0.09	0.01	0
1986	1580	131439	124	8	116	6.45	8.32	0.08	0.09	0.01	0
1987	1580	152958	92	3	89	3.26	9.68	0.06	0.06	0.00	0
1988	1580	173373	116	1	115	0.86	10.97	0.07	0.07	0.00	0
1989	1580	138453	68	6	62	8.82	8.76	0.04	0.05	0.00	0
1990	1600	141512	144	3	141	2.08	8.84	0.09	0.10	0.00	0
1991	2500	139105	101	3	98	2.97	5.56	0.04	0.07	0.00	0
1992	2528	168439	198	6	192	3.03	6.66	0.08	0.12	0.00	0
1993	2528	177639	82	15	67	18.29	7.03	0.03	0.05	0.01	0
1994	2528	200733	159	85	74	53.46	7.94	0.06	0.08	0.04	0
1995(P)	2581	155721	858	449	409	52.33	6.03	0.33	0.55	0.29	0

19. District : Nizamabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	1679	213914	177	15	162	8.47	12.74	0.11	0.08	0.01	0
1986	2275	182243	243	10	233	4.12	8.01	0.11	0.13	0.01	0
1987	2275	213064	507	19	488	3.75	9.37	0.22	0.24	0.01	0
1988	2275	198167	162	2	160	1.23	8.71	0.07	0.08	0.00	0
1989	2275	174118	123	6	117	4.88	7.65	0.05	0.07	0.00	0
1990	2275	165027	493	6	487	1.22	7.25	0.22	0.30	0.00	0
1991	2275	182131	732	153	579	20.90	8.01	0.32	0.40	0.08	0
1992	2275	153026	1425	86	1339	6.04	6.73	0.63	0.93	0.06	0
1993	2275	141888	1847	374	1473	20.25	6.24	0.81	1.30	0.26	0
1994	2275	149560	1833	390	1443	21.28	6.57	1.13	1.23	0.26	0
1995(P)	2322	131266	775	43	732	5.55	5.65	0.33	0.59	0.03	0

20. District : Adilabad

1985	1638	218187	2584	1639	945	63.43	13.32	1.58	1.18	0.75	0
1986	1841	147876	2322	1041	1281	44.83	8.03	1.26	1.57	0.70	0
1987	1887	257697	2943	1054	1889	35.81	13.66	1.56	1.14	0.41	0
1988	1938	296455	3299	643	2656	19.49	15.30	1.70	1.11	0.22	0
1989	1990	266574	2889	1084	1805	37.52	13.40	1.45	1.08	0.41	0
1990	2032	302290	4795	2640	2155	55.06	14.88	2.36	1.59	0.87	0
1991	2127	308652	6971	4193	2778	60.15	14.51	3.28	2.26	1.36	0
1992	2128	286663	4752	2495	2257	52.50	13.47	2.23	1.66	0.87	0
1993	2128	251659	5331	2716	2615	50.95	11.83	2.51	2.12	1.08	0
1994	2135	287070	6336	3326	3010	52.49	13.45	2.97	2.21	1.16	0
1995(P)	2179	263762	5168	2532	2636	48.99	12.10	2.37	1.96	0.96	0

ANDHRA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

21. District : Karimnagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	2436	317802	164	10	154	6.10	13.05	0.07	0.05	0.00	0
1986	2722	300274	846	184	662	21.75	11.03	0.31	0.28	0.06	0
1987	2722	324132	685	89	596	12.99	11.91	0.25	0.21	0.03	0
1988	2755	334300	337	30	307	8.90	12.13	0.12	0.10	0.01	0
1989											
1990	2812	307346	112	4	108	3.57	10.93	0.04	0.04	0.00	0
1991	3043	353087	805	507	298	62.98	11.60	0.26	0.23	0.14	0
1992	3048	348222	756	319	437	42.20	11.42	0.25	0.22	0.09	0
1993	3124	315313	1038	266	772	25.63	10.09	0.33	0.33	0.08	0
1994	3133	273100	1828	862	966	47.16	8.72	0.58	0.67	0.32	0
1995(P)	3198	236250	708	166	542	23.45	7.39	0.22	0.30	0.07	0

22. District : Warangal

1985	2309	317190	227	40	187	17.62	13.74	0.10	0.07	0.01	0
1986	2309	258455	192	23	169	11.98	11.19	0.08	0.07	0.01	0
1987	2681	337478	815	170	645	20.86	12.59	0.30	0.24	0.05	0
1988	2681	347155	707	51	656	7.21	12.95	0.26	0.20	0.01	0
1989	2731	318642	1055	150	905	14.22	11.67	0.39	0.33	0.05	0
1990	2731	318098	1211	378	833	31.21	11.65	0.44	0.38	0.12	0
1991	2731	351864	1056	341	715	32.29	12.88	0.39	0.30	0.10	0
1992	2731	380875	902	476	426	52.77	13.95	0.33	0.24	0.12	0
1993	2747	391067	1030	365	665	35.44	14.24	0.37	0.26	0.09	0
1994	2824	425786	1277	587	690	45.97	15.08	0.45	0.30	0.14	0
1995(P)	2883	386864	1424	728	696	51.12	13.42	0.49	0.37	0.19	0

23. District : Khammam

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	1745	258804	2745	2035	710	74.13	14.83	1.57	1.06	0.79	0
1986	1747	163463	2908	2147	761	73.83	9.36	1.66	1.78	1.31	0
1987	1782	218293	3553	2766	787	77.85	12.25	1.99	1.63	1.27	0
1988	1816	247581	2028	1579	449	77.86	13.63	1.12	0.82	0.64	0
1989	1835	250405	4363	3574	789	81.92	13.65	2.38	1.74	1.43	0
1990	1836	333516	15762	11914	3848	75.59	18.17	8.58	4.73	3.57	0
1991	1836	287280	7294	5742	1552	78.72	15.65	3.97	2.54	2.00	0
1992	1836	288948	3817	3125	692	81.87	15.74	2.08	1.32	1.08	0
1993	1924	301360	3977	3518	459	88.46	15.66	2.07	1.32	1.17	0
1994	1963	280623	3615	2949	666	81.58	14.30	1.84	1.29	1.05	0
1995(P)	2004	280026	2657	2219	438	83.52	13.97	1.33	0.95	0.79	0

24. VSP Impact Area

1994	214	41890	239	11	228	4.60	19.57	1.12	0.57	0.03	0

25. VSP Steel Plant

1994	24	17971	331	35	296	10.57	74.88	13.79	1.84	0.19	0

ARUNACHAL PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Tirap

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	151	47545	4788	2369	2419	49.48	31.49	31.71	10.07	4.98	0
1987	155	44914	4011	2331	1680	58.12	28.98	25.88	8.93	5.19	0
1988	163	41215	4016	1952	2064	48.61	25.29	24.64	9.74	4.74	2
1989	81	9280	572	426	146	74.48	11.46	7.06	6.16	4.59	0
1990	81	10533	533	373	160	69.98	13.00	6.58	5.06	3.54	0
1991	81	12237	1115	864	251	77.49	15.11	13.77	9.11	7.06	0
1992	83	11469	1209	844	365	69.81	13.82	14.57	10.54	7.36	0
1993	86	13224	1925	647	1288	33.61	15.38	22.38	14.56	4.89	0
1994	85	18011	2481	834	1647	23.95	21.19	29.19	13.77	4.63	0
1995(P)	86	16575	2356	401	1955	17.02	19.27	27.39	14.21	2.41	0

2. District : Changlang

1985	New Distt. created from Tirap in 1988										
1986											
1987											
1988											
1989	80	20595	2251	1068	1183	47.45	25.74	28.14	10.93	5.19	0
1990	80	23899	1799	742	1057	41.25	29.87	22.49	7.53	3.10	1
1991	80	24967	2367	918	1449	38.78	31.21	29.59	9.48	3.68	0
1992	83	24483	2652	1094	1558	41.25	29.50	31.95	10.83	4.47	0
1993	93	29861	3949	1837	2112	46.52	32.11	42.46	13.22	6.15	1
1994	90	39658	5817	2471	3346	42.47	44.06	64.63	14.67	6.23	6
1995(P)	91	43195	7350	2340	5010	31.83	47.46	80.76	17.01	5.41	0

3. District : Lohit including Dibang Valley

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	105	54615	3730	351	3379	9.41	52.01	35.52	6.83	0.64	0
1987	103	59948	2767	461	2306	16.66	58.20	26.86	4.62	0.77	0
1988	103	50127	2278	322	1956	14.14	48.66	22.11	4.54	0.64	0
1989	111	51258	2228	343	1885	15.39	46.18	20.07	4.35	0.67	0
1990	122	48025	1875	301	1574	16.05	39.36	15.37	3.90	0.63	0
1991	122	46463	2762	450	2312	16.29	38.08	22.64	5.94	0.97	0
1992	123	41742	3003	400	2603	13.32	33.94	24.41	7.19	0.96	0
1993	153	55296	8005	1260	6745	15.74	36.14	52.32	14.48	2.28	0
1994	138	85246	17290	4077	13213	23.58	61.77	125.29	20.28	4.78	0
1995(P)	140	53365	13706	2322	11384	16.94	38.11	97.92	25.68	4.35	1

4. District : East Siang

1985											
1986	82	35509	4711	839	3872	17.81	43.30	57.45	13.27	2.36	0
1987	85	34316	3785	228	3557	6.02	40.37	44.53	11.03	0.66	0
1988	87	36367	6040	570	5470	9.44	41.80	69.43	16.61	1.57	0
1989	105	44780	9523	483	9040	5.07	42.65	90.70	21.27	1.08	0
1990	105	33802	6634	289	6345	4.36	32.19	63.18	19.63	0.85	0
1991	105	32559	5876	242	5634	4.12	31.01	55.96	18.05	0.74	0
1992	105	34988	5160	245	4915	4.75	33.32	49.14	14.75	0.70	0
1993	102	32523	5587	127	5460	2.27	31.89	54.77	17.18	0.39	0
1994	107	49565	10770	1541	9229	8.48	46.32	100.65	21.73	3.10	0
1995(P)	109	32965	6872	406	6466	5.90	30.24	63.04	20.84	1.23	0

ARUNACHAL PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : West Siang

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	78	24362	2427	56	2371	2.31	31.23	31.12	9.96	0.23	0
1987	83	22760	2112	47	2065	2.23	27.42	25.45	9.28	0.21	0
1988	87	16152	1803	23	1780	1.28	18.57	20.72	11.16	0.14	0
1989	87	20659	1517	19	1498	1.25	23.74	17.43	7.34	0.09	0
1990	87	19138	2167	53	2114	2.45	21.99	24.90	11.32	0.28	0
1991	87	16741	959	4	955	0.42	19.24	11.02	5.73	0.02	0
1992	88	22218	2324	43	2281	1.85	25.25	26.41	10.46	0.19	0
1993	90	24093	2341	6	2335	0.26	26.77	26.01	9.72	0.02	0
1994	90	29649	4241	16	0	0.38	32.94	47.12	14.30	0.05	0
1995(P)	91	29985	7584	5	7579	0.06	32.95	83.34	25.29	0.01	0

6. District : Upper Subansiri

1985											
1986	44	27564	3036	114	2922	3.75	62.65	69.00	11.01	0.41	0
1987	44	19025	1723	114	1609	6.62	43.24	39.16	9.06	0.60	0
1988	45	21064	2252	193	2059	8.57	46.81	50.04	10.69	0.92	0
1989	45	20825	1674	115	1559	6.87	46.28	37.20	8.04	0.55	0
1990	45	17721	1494	201	1293	13.45	39.38	33.20	8.43	1.13	0
1991	45	16325	1425	80	1345	5.61	36.28	31.67	8.73	0.49	0
1992	46	15271	1426	62	1364	4.35	33.20	31.00	9.34	0.41	0
1993	50	18594	1767	61	1706	3.45	37.19	35.34	9.50	0.33	0
1994	50	19956	1841	91	1750	4.94	39.91	36.82	9.23	0.46	0
1995(P)	51	12460	1202	40	1162	3.32	24.43	100.00	9.64	0.00	0

ARUNACHAL PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Lower Subansiri

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	119	32746	2046	244	1802	11.93	27.52	17.19	6.25	0.75	0
1987	123	29722	2047	196	1851	9.57	24.16	16.64	6.89	0.66	0
1988	124	28873	2289	246	2043	10.75	23.28	18.46	7.93	0.85	0
1989	128	30175	2477	222	2255	8.96	23.57	19.35	8.21	0.74	0
1990	135	29610	2904	190	2714	6.54	21.93	21.51	9.81	0.64	0
1991	139	26209	2664	307	2357	11.52	18.86	19.17	10.16	1.17	0
1992	139	24112	2408	387	2021	16.07	17.35	17.32	9.99	1.61	0
1993	157	39812	5045	1103	3942	21.86	25.36	32.13	12.67	2.77	0
1994	168	51714	5488	1147	4341	20.28	30.78	32.67	10.61	2.21	0
1995(P)	171	43237	4245	1204	3041	28.36	25.28	24.82	9.81	2.78	0

8. District : East Kameng

1985											
1986	44	7072	838	79	759	9.43	16.07	19.05	11.85	1.12	0
1987	44	5447	291	48	243	16.49	12.38	6.61	5.34	0.88	0
1988	44	4249	265	37	228	13.96	9.66	6.02	6.24	0.87	0
1989	96	8575	623	89	534	14.29	8.93	6.49	7.27	1.04	0
1990	49	4141	631	24	607	3.80	8.45	12.88	15.24	0.58	0
1991	49	8493	1215	41	1174	3.37	17.33	24.80	14.31	0.48	0
1992	49	6500	789	22	767	2.79	13.27	16.10	12.14	0.34	0
1993	56	7640	891	10	881	1.12	13.64	15.91	11.66	0.13	0
1994	57	5582	1353	6	1347	0.44	9.79	23.74	24.24	0.11	0
1995(P)	58	7177	1424	55	1372	3.85	12.37	24.60	19.88	0.76	0

ARUNACHAL PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : West Kameng

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	58	2572	234	104	130	44.44	4.43	4.03	9.10	4.04	0
1987	51	3097	223	91	132	40.81	6.07	4.37	7.20	2.94	0
1988	52	3541	311	96	215	30.87	6.81	5.98	8.78	2.71	0
1989	96	8575	623	89	534	14.28	8.93	6.48			
1990	54	3030	190	32	158	16.84	5.61	3.52	6.27	1.06	0
1991	54	5301	346	79	267	22.83	9.82	6.41	6.53	1.49	0
1992	54	3218	142	23	119	16.20	5.96	2.63	4.41	0.71	0
1993	54	4154	154	21	133	13.64	7.69	2.85	3.71	0.51	0
1994	54	4665	422	76	346	18.01	8.64	7.81	9.05	1.63	0
1995(P)	55	2480	475	65	410	13.68	4.50	8.63	19.15	2.62	0

10. District : Tawang

	NOT	UNDER	NMEP								

ASSAM - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Dhubri

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1228	136403	6330	5159	1171	81.50	11.11	5.15	4.64	3.78	0
1987	1238	124663	4908	3894	1014	79.34	10.07	3.96	3.94	3.12	0
1988	1263	118711	4557	3951	606	86.70	9.40	3.61	3.84	3.33	3
1989	1279	135570	7135	6651	484	93.22	10.60	5.58	5.26	4.91	0
1990	1330	123367	7338	6703	635	91.35	9.28	5.52	5.95	5.43	0
1991	1350	150980	8325	7729	596	92.84	11.18	6.17	5.51	5.12	1
1992	1354	152079	6847	6396	451	93.41	11.23	5.06	4.50	4.21	0
1993	1389	202569	7297	6292	1005	86.23	14.58	5.25	3.60	3.11	0
1994	1405	226608	9378	8142	1236	86.82	16.13	6.67	4.14	3.59	10
1995(P)	1434	234998	12650	11118	1532	87.89	16.39	8.82	5.38	4.73	11

2. District : Goalpara

1985											
1986	1020	153950	4707	4270	437	0	0	0	0	0	0
1987	1030	103669	2333	2015	318	86.37	10.06	2.27	2.25	1.94	0
1988	1048	95843	2336	2074	262	88.78	9.15	2.23	2.44	2.17	0
1989	1074	103774	3544	3155	389	89.02	9.66	3.30	3.42	3.04	0
1990	1115	84351	1862	1586	276	85.18	7.57	1.67	2.21	1.88	0
1991	744	85808	2919	2471	448	84.65	11.53	3.92	3.40	2.88	0
1992	756	84935	2620	2333	287	89.05	11.23	3.47	3.08	2.75	0
1993	769	96657	2523	2284	239	90.53	12.57	3.28	2.61	2.36	0
1994	781	64181	3569	3373	196	94.51	8.22	4.57	5.56	5.26	0
1995(P)	797	107287	14311	12502	2009	85.96	13.46	17.96	13.34	11.47	9

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Kokrajhar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1011	172657	11371	7183	4188	63.17	17.08	11.25	6.59	4.16	0
1987	1024	173311	9981	6713	3268	67.26	16.92	9.75	5.76	3.87	0
1988	1056	159086	9920	7317	2603	73.76	15.06	9.39	6.24	4.60	0
1989	1056	102668	6507	4865	1642	74.77	9.72	6.16	6.34	4.74	0
1990	1085	142080	13500	10654	2846	78.92	13.09	12.44	9.50	7.50	0
1991	1097	221527	21855	19709	2146	90.18	20.19	19.92	9.87	8.90	4
1992	691	131591	13173	11220	1953	85.17	19.04	19.06	10.01	8.53	0
1993	702	152644	13805	10514	3291	76.16	21.74	19.67	9.04	6.89	0
1994	705	140294	17693	15203	2490	85.93	19.90	25.10	12.61	10.84	6
1995(P)	719	78230	7500	6436	1064	85.81	10.88	10.43	9.59	8.23	5

4. District : Barpeta

1985											
1986	1289	112487	2103	1600	503	76.08	8.73	1.63	1.87	1.42	0
1987	1345	71068	1400	790	610	56.43	5.28	1.04	1.97	1.11	0
1988	1372	82322	855	776	79	90.76	6.00	0.62	1.04	0.94	0
1989	1372	86969	2267	1933	334	85.27	6.34	1.65	2.61	2.22	0
1990	1386	101169	2096	1460	636	69.66	7.30	1.51	2.07	1.44	0
1991	1401	131484	8605	6656	1949	77.35	9.39	6.14	6.54	5.06	19
1992	1402	94711	2991	2216	775	74.09	6.76	2.13	3.16	2.34	0
1993	1428	95998	2368	1985	383	83.83	6.72	1.66	2.47	2.07	0
1994	1445	103441	3457	2774	683	80.24	7.16	2.39	3.34	2.68	0
1995(P)	1475	130206	1673	3998	2175	64.77	8.83	4.19	4.74	3.07	6

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District: Nalbari

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	986	165234	27638	23451	4187	84.85	16.67	20.03	16.73	14.19	0
1987	986	60248	3200	2278	922	71.19	6.11	3.25	5.31	3.78	0
1988	1030	68424	1731	1210	521	69.90	6.64	1.68	2.53	1.77	0
1989	1031	71654	2043	1594	449	78.02	6.95	1.98	2.85	2.22	1
1990	1060	64690	2025	1473	552	72.74	6.10	1.91	3.13	2.28	9
1991	1069	66871	1621	1373	248	84.70	6.26	1.52	2.42	2.05	0
1992	1101	60635	1246	1134	112	91.01	5.51	1.13	2.05	1.87	0
1993	1118	56147	750	636	114	84.80	5.02	0.67	1.34	1.13	0
1994	1132	73965	2066	1793	273	86.79	6.53	1.83	2.79	2.42	1
1995(P)	1155	328690	42934	35091	7843	81.73	28.46	37.17	13.06	10.68	8

6. District : Kamrup

1985											
1986	1777	166130	13022	11197	1825	85.99	9.35	7.33	7.84	6.74	0
1987	1803	148911	8473	7106	1367	83.87	8.26	4.70	5.69	4.77	0
1988	1885	119468	4250	3429	821	80.68	6.34	2.25	3.56	2.87	1
1989	1903	125256	4712	3977	735	84.40	6.58	2.48	3.76	3.18	1
1990	1929	115703	4437	3319	1118	74.80	6.00	2.30	3.83	2.87	0
1991	1937	133639	10630	9131	1499	85.90	6.90	5.49	7.95	6.83	4
1992	1960	145665	12452	10774	1678	86.52	7.43	6.35	8.55	7.40	0
1993	1952	185412	15514	13624	1890	87.82	9.50	7.95	8.37	7.35	0
1994	1971	199814	24276	22075	2201	90.93	10.14	12.32	12.15	11.05	0
1995(P)	2012	114766	11438	9982	1456	87.27	5.70	5.68	9.97	8.70	2

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Darrang (Mangaldoi)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1244	200287	14621	4812	9809	32.91	16.10	11.75	7.30	2.40	0
1987	1288	169357	9844	908	8936	9.22	13.15	7.64	5.81	0.54	0
1988	1318	156282	8245	270	7975	3.27	11.86	6.26	5.28	0.17	0
1989	1325	142406	10363	1105	9258	10.66	10.75	7.82	7.28	0.78	0
1990	1341	146722	13275	245	13030	1.85	10.94	9.90	9.05	0.17	0
1991	1364	173565	18135	271	17864	1.49	12.72	13.30	10.45	0.16	0
1992	1374	164294	20699	1829	18870	8.84	11.96	15.06	12.60	1.11	0
1993	1386	180214	22694	4292	18402	18.91	13.00	16.37	12.59	2.38	0
1994	1392	181490	23441	3173	20268	13.54	13.04	16.84	12.92	1.75	6
1995(P)	1421	215047	29329	3697	25632	12.61	15.13	20.64	13.64	1.72	6

8. District : Sonitpur (Tezpur)

1985											
1986	1310	132232	2748	883	1865	32.13	10.09	2.10	2.08	0.67	0
1987	1325	97404	1745	542	1203	31.06	7.35	1.32	1.79	0.56	0
1988	1357	97428	1912	698	1214	36.51	7.18	1.41	1.96	0.72	0
1989	1413	102150	2441	647	1794	26.51	7.23	1.73	2.39	0.63	0
1990	1440	92869	2139	456	1683	21.32	6.45	1.49	2.30	0.49	0
1991	1470	116205	6050	2403	3647	39.72	7.91	4.12	5.21	2.07	6
1992	1517	101153	3538	1534	2004	43.36	6.67	2.33	3.50	1.52	0
1993	1564	141264	9627	4307	5320	44.74	9.03	6.16	6.81	3.05	0
1994	1615	187636	20092	9582	5320	47.69	11.62	12.44	10.71	5.11	13
1995(P)	1648	200414	23291	9487	13804	40.73	12.16	14.13	11.62	4.73	34

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : Lakhimpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1187	103923	1119	79	1040	7.06	8.76	0.94	1.08	0.08	0
1987	1207	98064	1226	121	1105	9.87	8.12	1.02	1.25	0.12	0
1988	1236	91190	539	68	471	12.62	7.38	0.44	0.59	0.07	0
1989	1360	97387	664	34	630	5.12	7.16	0.49	0.68	0.03	0
1990	1289	86077	652	92	560	14.11	6.68	0.51	0.76	0.11	0
1991	801	50367	133	20	113	15.04	6.29	0.17	0.26	0.04	0
1992	844	48994	228	39	189	17.11	5.80	0.27	0.47	0.08	0
1993	850	71081	509	92	417	18.07	8.36	0.60	0.72	0.13	0
1994	877	79913	3165	605	2560	19.12	9.11	3.61	3.96	0.76	0
1995(P)	895	109828	7004	2455	4549	35.05	12.27	7.83	6.38	2.24	12

10. District : Dibrugarh

1985											
1986	2217	237469	591	317	274	53.64	10.71	0.27	0.25	0.13	0
1987	2241	224735	513	333	180	64.91	10.03	0.23	0.23	0.15	0
1988	2277	228939	557	318	239	57.09	10.05	0.24	0.24	0.14	0
1989	2299	231338	650	430	220	66.15	10.06	0.28	0.28	0.19	0
1990	2349	249506	325	201	124	61.85	10.62	0.14	0.13	0.08	0
1991	1264	125890	51	40	11	78.43	9.96	0.04	0.04	0.03	0
1992	1300	133508	64	45	19	70.31	10.27	0.05	0.05	0.03	0
1993	1316	121329	95	72	23	75.79	9.22	0.07	0.08	0.06	0
1994	1329	122482	98	73	25	74.49	9.22	0.07	0.08	0.06	0
1995(p)	1356	119441	111	72	39	64.86	8.81	0.08	0.09	0.06	0

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Sibsagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1024	95681	242	136	106	56.20	9.34	0.24	0.25	0.14	0
1987	1039	84213	117	67	50	57.26	8.11	0.11	0.14	0.08	0
1988	1042	90212	107	57	50	53.27	8.66	0.10	0.12	0.06	0
1989	1045	92738	62	35	27	56.45	8.87	0.06	0.07	0.04	0
1990	1061	82953	40	20	20	50.00	7.82	0.04	0.05	0.02	0
1991	1093	76264	37	19	18	51.35	6.98	0.03	0.05	0.02	0
1992	1094	74368	31	15	16	48.39	6.80	0.03	0.04	0.02	0
1993	1097	87529	38	21	17	55.26	7.98	0.03	0.04	0.02	0
1994	1100	90554	41	19	22	46.34	8.23	0.04	0.05	0.02	1
1995(p)	1123	93664	75	38	37	50.67	8.34	0.07	0.08	0.04	1

12. District : Jorhat

1985											
1986	1783	203033	329	107	222	32.52	11.39	0.18	0.16	0.05	0
1987	995	82262	85	15	70	17.65	8.27	0.09	0.10	0.02	0
1988	1030	73579	94	32	62	34.04	7.14	0.09	0.13	0.04	0
1989	1046	97730	94	43	51	45.74	9.34	0.09	0.10	0.04	0
1990	1057	101057	39	12	27	30.77	9.56	0.04	0.04	0.01	0
1991	1074	102598	39	10	29	25.64	9.55	0.04	0.04	0.01	0
1992	1086	102816	67	22	45	32.84	9.47	0.06	0.07	0.02	0
1993	1100	103661	168	64	104	38.10	9.42	0.15	0.16	0.06	0
1994	1066	108829	307	150	157	48.86	10.21	0.29	0.28	0.14	1
1995 (P)	1088	108524	1745	1620	125	92.84	9.97	1.60	1.61	1.49	1

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

13. District : Golaghat

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987	823	91819	523	188	335	35.95	11.16	0.64	0.57	0.20	0
1988	844	95095	303	135	168	44.55	11.27	0.36	0.32	0.14	0
1989	861	110803	465	244	221	52.47	12.87	0.54	0.42	0.22	0
1990	879	113397	238	54	184	22.69	12.90	0.27	0.21	0.05	0
1991	883	113802	260	87	173	33.46	12.89	0.29	0.23	0.08	0
1992	899	114148	627	221	406	35.25	12.70	0.70	0.55	0.19	0
1993	921	118224	606	320	286	52.81	12.84	0.66	0.51	0.27	0
1994	930	131140	2451	935	1516	38.15	14.10	2.64	1.87	0.71	2
1995(P)	949	114544	2434	697	1737	28.64	12.07	2.56	2.12	0.61	9

14. District : Nagaon

1985											
1986	2185	289629	4510	3291	1219	72.97	13.26	2.06	1.56	1.14	0
1987	2222	270818	4076	2011	2065	49.34	12.19	1.83	1.51	0.74	0
1988	2229	280447	3710	1596	2114	43.02	12.58	1.66	1.32	0.57	0
1989	2308	286477	5085	2297	2786	45.17	12.41	2.20	1.78	0.80	2
1990	2367	232579	3416	1806	1610	52.87	9.83	1.44	1.47	0.78	4
1991	1858	211446	4196	2873	1323	68.47	11.38	2.26	1.98	1.36	1
1992	1885	225676	3925	2645	1280	67.39	11.97	2.08	1.74	1.17	0
1993	1853	255638	7064	5549	1515	78.55	13.80	3.81	2.76	2.17	0
1994	1878	265964	8029	4872	3157	60.68	14.16	4.28	3.02	1.83	4
1995(P)	1917	302022	13925	7521	6404	54.01	15.75	7.26	4.61	2.49	27

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

15. District : Karbi - Anglong

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	570	128594	14108	10199	3909	72.29	22.56	24.75	10.97	7.93	0
1987	578	117280	9790	7108	2682	72.60	20.29	16.94	8.35	6.06	0
1988	589	128170	10753	8533	2220	79.35	21.76	18.26	8.39	6.66	0
1989	605	103998	11663	9267	2396	79.46	17.19	19.28	11.21	8.91	0
1990	612	103991	9563	7812	1751	81.69	16.99	15.63	9.20	7.51	2
1991	624	118921	14139	12032	2107	85.10	19.06	22.66	11.89	10.12	1
1992	634	108165	14036	11306	2730	80.55	17.06	22.14	12.98	10.45	0
1993	655	131245	14910	11992	2918	80.43	20.04	22.76	11.36	9.14	9
1994	669	143188	16878	13707	3171	81.21	21.40	25.23	11.79	9.57	0
1995(P)	683	145649	16181	11031	5150	68.17	21.32	23.69	11.11	7.57	11

16. District : N.C. Hills Haflong

1985											
1986	143	31266	2140	1206	934	56.36	21.86	14.97	6.84	3.86	0
1987	146	30415	1737	903	834	51.99	20.83	11.90	5.71	2.97	0
1988	146	31385	1588	886	702	55.79	21.50	10.88	5.06	2.82	0
1989	149	36130	1783	1124	659	63.04	24.25	11.97	4.93	3.11	0
1990	153	29919	1598	1061	537	66.40	19.55	10.44	5.34	3.55	0
1991	155	33007	2653	2087	566	78.67	21.29	17.12	8.04	6.32	0
1992	158	31006	2264	1597	667	70.54	19.62	14.33	7.30	5.15	0
1993	172	35955	2248	1658	590	73.75	20.90	13.07	6.25	4.61	0
1994	169	41760	3494	2289	1205	65.51	24.71	20.67	8.37	5.48	3
1995(P)	172	46332	4633	3067	1566	66.20	26.94	26.94	10.00	6.62	6

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

17. District :Cachar Silchar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1700	203031	6490	5882	608	90.63	11.94	3.82	3.20	2.90	0
1987	1757	164015	3180	2785	395	87.58	9.33	1.81	1.94	1.70	0
1988	1789	158111	4005	3730	275	93.13	8.84	2.24	2.53	2.36	0
1989	1815	146822	2277	2032	245	89.24	8.09	1.25	1.55	1.38	0
1990	1836	132891	1872	1703	169	90.97	7.24	1.02	1.41	1.28	1
1991	1279	120595	2830	2692	138	95.12	9.43	2.21	2.35	2.23	0
1992	1298	124573	2110	2020	90	95.73	9.60	1.63	1.69	1.62	0
1993	1318	131499	1916	1860	56	97.08	9.98	1.45	1.46	1.41	0
1994	1333	114916	3269	3214	55	98.32	8.62	2.45	2.84	2.80	4
1995(P)	1360	101252	1621	1318	303	81.31	7.45	1.19	1.60	1.30	2

18. District :Karimganj

1985											
1986	781	91236	1066	790	276	74.11	11.68	1.36	1.17	0.87	0
1987	827	69926	727	464	263	63.82	8.46	0.88	1.04	0.66	0
1988	850	72790	572	328	244	57.34	8.56	0.67	0.79	0.45	0
1989	875	71679	519	324	195	62.43	8.19	0.59	0.72	0.45	1
1990	912	70290	456	279	177	61.18	7.71	0.50	0.65	0.40	0
1991	932	81029	605	305	300	50.41	8.69	0.65	0.75	0.38	0
1992	949	82718	440	287	153	65.23	8.72	0.46	0.53	0.35	0
1993	966	86213	652	421	231	64.57	8.92	0.67	0.76	0.49	0
1994	983	90178	580	438	142	75.52	9.17	0.59	0.64	0.49	0
1995(P)	1003	119110	4935	4894	41	99.17	11.88	4.92	4.14	4.11	4

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

19. District : Hailkandi (Cachar)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1991										
1986											
1987											
1988											
1989											
1990											
1991	575	57386	737	716	21	97.15	9.98	1.28	1.28	1.25	0
1992	580	56320	363	338	25	93.11	9.71	0.63	0.64	0.60	0
1993	966	86213	652	421	231	64.57	8.92	0.67	0.76	0.49	0
1994	590	52604	311	279	32	89.71	8.92	0.53	0.59	0.53	0
1995(P)	602	48900	4913	3855	1058	78.47	8.12	8.16	10.05	7.88	0

20. District : Marigaon (Nagaon)

1985	New Distt.created in 1991										
1986											
1987											
1988											
1989											
1990											
1991	546	47028	670	461	209	68.81	8.61	1.23	1.42	0.98	0
1992	557	52418	850	484	366	56.94	9.41	1.53	1.62	0.92	0
1993	602	54019	742	378	364	50.94	8.97	1.23	1.37	0.70	0
1994	613	58945	591	282	309	47.72	9.62	0.96	1.00	0.48	0
1995(P)	625	78698	2196	718	1478	32.70	12.59	3.51	2.79	0.91	5

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

21. District : Bongaigaon

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New	Distt.created in 1991									
1986											
1987											
1988											
1989											
1990											
1991	402	40474	1349	1271	78	94.22	10.07	3.36	3.33	3.14	0
1992	838	100929	5537	5353	184	96.68	12.04	6.61	5.49	5.30	0
1993	851	132513	9288	8860	428	95.39	15.57	10.91	7.01	6.69	0
1994	839	109629	10507	9985	522	95.03	13.07	12.52	9.58	9.11	2
1995(P)	856	126160	865	8255	396	95.42	14.74	10.11	6.86	6.54	1

22. District : Tinsukia

1985	New	Distt.created in 1991									
1986											
1987											
1988											
1989											
1990											
1991	1116	117096	614	500	114	81.43	10.49	0.55	0.52	0.43	0
1992	1124	120800	336	204	132	60.71	10.75	0.30	0.28	0.17	0
1993	1129	130750	2793	1147	1646	41.07	11.58	2.47	2.14	0.88	0
1994	1154	121109	3849	1726	2123	44.84	10.49	3.34	3.18	1.43	7
1995(P)	1178	160855	6843	2767	4076	40.44	13.65	5.81	4.25	1.72	3

ASSAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

23. District :Dhimaji

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt.created in 1991										
1986											
1987											
1988											
1989											
1990											
1991	494	36183	1119	138	981	12.33	7.32	2.27	3.09	0.38	0
1992	477	31830	724	106	618	14.64	6.67	1.52	2.27	0.33	0
1993	491	50780	2423	796	1627	32.85	10.34	4.93	4.77	1.57	0
1994	506	41721	2996	780	2216	26.03	8.25	5.92	7.18	1.87	0
1995(P)	516	45912	4512	1263	3249	27.99	8.90	8.74	9.83	2.75	16

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

1. District : Patna

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3346	46742	76	4	72	5.26	1.40	0.02	0.16	0.01	0
1987	3449	33959	30	0	30	0.00	0.98	0.01	0.09	0.00	0
1988	3449	22599	47	6	41	12.77	0.66	0.01	0.21	0.03	0
1989	3518	46026	62	1	61	1.61	1.31	0.02	0.13	0.00	0
1990	3603	36044	103	7	96	6.80	1.00	0.03	0.29	0.02	0
1991	3623	30220	36	2	34	5.56	0.83	0.01	0.12	0.01	0
1992	3770	25887	45	0	45	0.00	0.69	0.01	0.17	0.00	0
1993	3845	23842	57	4	53	7.02	0.62	0.01	0.24	0.02	0
1994	3922	25122	34	3	31	8.82	0.64	0.01	0.14	0.01	0
1995(P)	4004	13499	39	0	39	0.00	0.34	0.01	0.29	0.00	0

2. District : Nalanda

1985											
1986	1802	58532	10	0	10	0.00	3.25	0.01	0.02	0.00	0
1987	1875	51932	0	0	0	0.00	2.77	0.00	0.00	0.00	0
1988	1875	41814	0	0	0	0.00	2.23	0.00	0.00	0.00	0
1989	1913	46317	0	0	0	0.00	2.42	0.00	0.00	0.00	0
1990	1958	41403	4	0	4	0.00	2.11	0.00	0.01	0.00	0
1991	2003	33587	20	0	20	0.00	1.68	0.01	0.06	0.00	0
1992	2092	42497	23	0	23	0.00	2.03	0.01	0.05	0.00	0
1993	2138	29829	6	0	6	0.00	1.40	0.00	0.02	0.00	0
1994	2186	36300	15	0	15	0.00	1.66	0.01	0.04	0.00	0
1995(P)	2231	29004	9	2	7	0.22	1.30	0.00	0.03	0.01	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

3. District : Gaya

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3464	76620	84	1	83	1.19	2.21	0.02	0.11	0.00	0
1987	2497	48795	49	1	48	2.04	1.95	0.02	0.10	0.00	0
1988	2497	36569	21	0	21	0.00	1.46	0.01	0.06	0.00	0
1989	2547	38799	36	0	36	0.00	1.52	0.01	0.09	0.00	0
1990	2608	39207	24	10	14	41.67	1.50	0.01	0.06	0.03	0
1991	2665	34840	9	3	6	33.33	1.31	0.00	0.03	0.01	0
1992	2789	35060	8	3	5	37.50	1.26	0.00	0.02	0.01	0
1993	2853	35148	9	1	8	11.11	1.23	0.00	0.03	0.00	0
1994	2919	36105	4	0	4	0.00	1.24	0.00	0.01	0.00	0
1995(P)	2980	22998	4	2	2	0.5	0.77	0.00	0.02	0.01	0

4. District : Jahanabad

1985	New district created in 1987										
1986											
1987	1092	11098	0	0	0	0.00	1.02	0.00	0.00	0.00	0
1988	1092	4877	2	0	2	0.00	0.45	0.00	0.04	0.00	0
1989	1113	10820	3	1	2	33.33	0.97	0.00	0.03	0.01	0
1990	1140	9759	1	1	0	100.00	0.86	0.00	0.01	0.01	0
1991	1173	9048	2	0	2	0.00	0.77	0.00	0.02	0.00	0
1992	1218	8285	1	0	1	0.00	0.68	0.00	0.01	0.00	0
1993	1241	8175	0	0	0	0.00	0.66	0.00	0.00	0.00	0
1994	1265	6957	0	0	0	0.00	0.55	0.00	0.00	0.00	0
1995(P)	1291	3507	3	0	3	0.00	0.27	0.00	0.09	0.00	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

5. District : Nawada

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1213	51998	66	24	42	36.36	4.29	0.05	0.13	0.05	0
1987	1256	43968	74	32	42	43.24	3.50	0.06	0.17	0.07	0
1988	1256	44935	89	37	52	41.57	3.58	0.07	0.20	0.08	0
1989	1281	41443	290	114	176	39.31	3.24	0.23	0.70	0.28	0
1990	1312	38771	314	154	160	49.04	2.96	0.24	0.81	0.40	0
1991	1358	40779	359	302	57	84.12	3.00	0.26	0.88	0.74	1
1992	1422	33617	888	584	304	65.77	2.36	0.62	2.64	1.74	0
1993	1454	30713	519	315	204	60.69	2.11	0.36	1.69	1.03	0
1994	1488	20898	560	263	297	46.96	1.40	0.38	2.68	1.26	0
1995(P)	1519	18848	239	79	160	33.05	1.24	0.16	1.27	0.42	0

6. District : Aurangabad

1985											
1986	1371	20078	669	50	619	7.47	1.46	0.49	3.33	0.25	0
1987	1413	18159	580	51	529	8.79	1.29	0.41	3.19	0.28	0
1988	1413	15123	458	19	439	4.15	1.07	0.32	3.03	0.13	0
1989	1441	14217	418	8	410	1.91	0.99	0.29	2.94	0.06	0
1990	1470	14030	437	35	402	8.01	0.95	0.30	3.11	0.25	0
1991	1538	12890	1076	69	1007	6.41	0.84	0.70	8.35	0.54	0
1992	1613	12348	713	49	664	6.87	0.77	0.44	5.77	0.40	0
1993	1651	11450	1123	67	1056	5.97	0.69	0.68	9.81	0.59	0
1994	1691	10985	973	117	856	12.02	0.65	0.58	8.86	1.07	0
1995(P)	1726	10053	1404	111	1293	7.90	0.58	0.81	13.97	1.10	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

7. District : Bhojpur

Year	Pop. ('000 s)	BSE	Positives	Pf	Pv	Pf %	ABER	API	SPR	SfR	Deaths
1985											
1986	2637	41529	24	4	20	16.67	1.57	0.01	0.06	0.01	0
1987	2750	34309	2	0	2	0.00	1.25	0.00	0.01	0.00	0
1988	2756	34979	7	0	7	0.00	1.27	0.00	0.02	0.00	0
1989	2805	40025	15	0	15	0.00	1.43	0.01	0.04	0.00	0
1990	2861	38153	6	1	5	16.67	1.33	0.00	0.02	0.00	0
1991	2867	35226	16	1	15	6.25	1.23	0.01	0.05	0.00	0
1992	2977	33054	6	0	6	0.00	1.11	0.00	0.02	0.00	0
1993	3034	34254	1	0	1	0.00	1.13	0.00	0.00	0.00	0
1994	3092	34708	3	0	3	0.00	1.12	0.00	0.01	0.00	0
1995											

8. District : Rohtas

1985											
1986	2609	77958	1227	360	867	29.34	2.99	0.47	1.57	0.46	0
1987	2703	87326	1265	409	856	32.33	3.23	0.47	1.45	0.47	0
1988	2763	99148	1264	333	931	26.34	3.59	0.46	1.27	0.34	0
1989	2757	99774	1623	421	1202	25.94	3.62	0.59	1.63	0.42	0
1990	2813	99660	1422	258	1164	18.14	3.54	0.51	1.43	0.26	0
1991	2890	72852	1563	448	1115	28.66	2.52	0.54	2.15	0.61	0
1992	3019	70522	1616	302	1314	18.69	2.34	0.54	2.29	0.43	0
1993	3085	64313	2111	280	1831	13.26	2.08	0.68	3.28	0.44	0
1994	3153	49789	1907	123	1784	6.45	1.58	0.60	3.83	0.25	0
1995											

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

9. District : Saran

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2289	47628	13	1	12	7.69	2.08	0.01	0.03	0.00	0
1987	2281	40348	27	0	27	0.00	1.77	0.01	0.07	0.00	0
1988	2381	42084	8	0	8	0.00	1.77	0.00	0.02	0.00	0
1989	2429	37944	11	0	11	0.00	1.56	0.00	0.03	0.00	0
1990	2477	33377	5	0	5	0.00	1.35	0.00	0.01	0.00	0
1991	2563	29538	8	0	8	0.00	1.15	0.00	0.03	0.00	0
1992	2682	17077	2	0	2	0.00	0.64	0.00	0.01	0.00	0
1993	2744	21413	3	0	3	0.00	0.78	0.00	0.01	0.00	0
1994	2807	24044	1	0	1	0.00	0.86	0.00	0.00	0.00	0
1995 (P)	2865	23237	61	6	55	9.83	0.81	0.02	0.26	0.03	0

10. District : Siwan

1985											
1986	1962	59947	109	1	108	0.92	3.06	0.06	0.18	0.00	0
1987	2032	55343	161	4	157	2.48	2.72	0.08	0.29	0.01	0
1988	2032	46421	137	0	137	0.00	2.28	0.07	0.30	0.00	0
1989	2073	56450	152	2	150	1.32	2.72	0.07	0.27	0.00	0
1990	2123	54695	125	3	122	2.40	2.58	0.06	0.23	0.01	0
1991	2159	50531	140	0	140	0.00	2.34	0.06	0.28	0.00	0
1992	2251	46262	190	23	167	12.11	2.06	0.08	0.41	0.05	0
1993	2298	46257	176	25	151	14.20	2.01	0.08	0.38	0.05	0
1994	2346	43879	52	11	41	21.15	1.87	0.02	0.12	0.03	0
1995(P)	2395	32724	24	7	17	29.16	1.37	0.01	0.07	0.02	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

11. District : Gopalganj

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1503	33003	121	6	115	4.96	2.20	0.08	0.37	0.02	0
1987	1556	30573	54	9	45	16.67	1.96	0.03	0.18	0.03	0
1988	1556	21233	27	5	22	18.52	1.36	0.02	0.13	0.02	0
1989	1587	27883	39	7	32	17.95	1.76	0.02	0.14	0.03	0
1990	1619	29242	51	8	43	15.69	1.81	0.03	0.17	0.03	0
1991	1701	25356	52	3	49	5.77	1.49	0.03	0.21	0.01	0
1992	1784	18269	35	7	28	20.00	1.02	0.02	0.19	0.04	0
1993	1827	13836	42	4	38	9.52	0.76	0.02	0.30	0.03	0
1994	1871	13337	31	4	27	12.90	0.71	0.02	0.23	0.03	0
1995(P)	1910	12938	42	5	37	11.90	0.68	0.02	0.32	0.04	0

12. District : East Champaran

1985											
1986	2679	39476	199	0	199	0.00	1.47	0.07	0.50	0.00	0
1987	2771	34179	87	0	87	0.00	1.23	0.03	0.25	0.00	0
1988	2771	28200	22	0	22	0.00	1.02	0.01	0.08	0.00	0
1989	2826	37139	65	0	65	0.00	1.31	0.02	0.18	0.00	0
1990	2883	29105	72	0	72	0.00	1.01	0.02	0.25	0.00	0
1991	3042	28220	81	0	81	0.00	0.93	0.03	0.29	0.00	0
1992	3196	21712	72	0	72	0.00	0.68	0.02	0.33	0.00	0
1993	3276	20690	20	0	20	0.00	0.63	0.01	0.10	0.00	0
1994	3358	21168	6	0	6	0.00	0.63	0.00	0.03	0.00	0
1995(P)	3428	12316	0	0	0	0.00	0.36	0.00	0.00	0.00	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

13. District : West Champaran

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2172	87876	35	5	30	14.29	4.04	0.02	0.04	0.01	0
1987	2254	85926	12	1	11	8.33	3.81	0.01	0.01	0.00	0
1988	2254	78873	4	0	4	0.00	3.50	0.00	0.01	0.00	0
1989	2299	74395	2	0	2	0.00	3.24	0.00	0.00	0.00	0
1990	2345	76934	5	0	5	0.00	3.28	0.00	0.01	0.00	0
1991	2331	57061	4	0	4	0.00	2.45	0.00	0.01	0.00	0
1992	2415	49230	2	0	2	0.00	2.04	0.00	0.00	0.00	0
1993	2459	49420	4	0	4	0.00	2.01	0.00	0.01	0.00	0
1994	2503	38987	1	1	0	100.00	1.56	0.00	0.00	0.00	0
1995(P)	2555	19776	5	0	5	0.00	0.77	0.00	0.03	0.00	0

14. District : Muzaffarpur

1985											
1986	2597	33840	146	6	140	4.1	1.30	0.06	0.43	0.02	0
1987	2693	31130	82	0	82	0.00	1.16	0.03	0.26	0.00	0
1988	2690	30474	76	0	76	0.00	1.13	0.03	0.25	0.00	0
1989	2745	28180	92	0	92	0.00	1.03	0.03	0.33	0.00	0
1990	2802	24160	96	0	96	0.00	0.86	0.03	0.40	0.00	0
1991	2947	25564	179	0	179	0.00	0.87	0.06	0.70	0.00	0
1992	3090	22350	263	0	263	0.00	0.72	0.09	1.18	0.00	0
1993	3164	25035	195	2	193	1.03	0.79	0.06	0.78	0.01	0
1994	3240	24348	137	1	136	0.73	0.75	0.04	0.56	0.00	0
1995(P)	3308	14202	78	1	77	1.28	0.42	0.02	0.55	0.01	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

15. District : Sitamarhi

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2130	51025	541	9	532	1.66	2.40	0.25	1.06	0.02	0
1987	2207	54313	267	4	263	1.50	2.46	0.12	0.49	0.01	0
1988	2207	38415	118	1	117	0.85	1.74	0.05	0.31	0.00	0
1989	2251	40754	90	2	88	2.22	1.81	0.04	0.22	0.00	0
1990	2296	45056	49	0	49	0.00	1.96	0.02	0.11	0.00	0
1991	2389	33422	18	1	17	5.56	1.40	0.01	0.05	0.00	0
1992	2500	26024	7	0	7	0.00	1.04	0.00	0.03	0.00	0
1993	2557	18936	7	0	7	0.00	0.74	0.00	0.04	0.00	0
1994	2616	24767	12	2	10	16.67	0.95	0.00	0.05	0.01	0
1995 (P)	2670	20431	21	0	21	0.00	0.76	0.01	0.10	0.00	0

16. District : Vaishali

1985											
1986	1839	23548	3	1	2	33.33	1.28	0.00	0.01	0.00	0
1987	1899	17781	2	0	2	0.00	0.00	0.94	0.00	0.00	0
1988	1899	12139	0	0	0	0.00	0.64	0.00	0.00	0.00	0
1989	1937	16274	1	1	0	100.00	0.84	0.00	0.01	0.01	0
1990	1976	16943	0	0	0	0.00	0.86	0.00	0.00	0.00	0
1991	2144	16993	1	1	0	100.00	0.79	0.00	0.01	0.01	0
1992	2266	17016	1	1	0	100.00	0.75	0.00	0.01	0.01	0
1993	2339	14979	0	0	0	0.00	0.64	0.00	0.00	0.00	0
1994	2395	17205	0	0	0	0.00	0.72	0.00	0.00	0.00	0
1995(P)	2445	16643	1	0	.1	0.00	0.68	0.00	0.01	0.00	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

17. District : Darbhanga

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2212	32252	140	3	137	2.14	1.46	0.06	0.43	0.01	0
1987	2294	32172	73	0	73	0.00	1.40	0.03	0.23	0.00	0
1988	2294	22899	94	4	90	4.26	1.00	0.04	0.41	0.02	0
1989	2340	34592	80	0	80	0.00	1.48	0.03	0.23	0.00	0
1990	2387	32656	82	0	82	0.00	1.37	0.03	0.25	0.00	0
1991	2509	22785	18	0	18	0.00	0.91	0.01	0.08	0.00	0
1992	2631	14458	12	0	12	0.00	0.55	0.00	0.08	0.00	0
1993	2694	21785	25	0	25	0.00	0.81	0.01	0.11	0.00	0
1994	2759	13718	14	0	14	0.00	0.50	0.01	0.10	0.00	0
1995(P)	2816	7868	6	0	6	0.00	0.27	0.00	0.08	0.00	0

18. District : Madhubani

1985											
1986	2565	43848	69	0	69	0.00	1.71	0.03	0.16	0.00	0
1987	2657	33908	52	0	52	0.00	1.28	0.02	0.15	0.00	0
1988	2657	41575	36	1	35	2.78	1.56	0.01	0.09	0.00	0
1989	2710	41067	34	1	33	2.94	1.52	0.01	0.08	0.00	0
1990	2764	43502	11	0	11	0.00	1.57	0.00	0.03	0.00	0
1991	2829	30274	17	0	17	0.00	1.07	0.01	0.06	0.00	0
1992	2954	24686	10	0	10	0.00	0.84	0.00	0.04	0.00	0
1993	3019	22786	1	0	1	0.00	0.75	0.00	0.00	0.00	0
1994	3086	36605	8	3	5	37.50	1.19	0.00	0.02	0.01	0
1995(P)	3150	19972	7	0	7	0.00	0.63	0.00	0.04	0.00	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

19. District : Samastipur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2336	42620	409	9	400	2.20	1.82	0.18	0.96	0.02	0
1987	2418	25220	195	14	181	7.18	1.04	0.08	0.77	0.06	0
1988	2418	17801	119	1	118	0.84	0.74	0.05	0.67	0.01	0
1989	2467	19971	241	0	241	0.00	0.81	0.10	1.21	0.00	0
1990	2516	13936	241	0	241	0.00	0.55	0.10	1.73	0.00	0
1991	2715	4531	267	0	267	0.00	0.17	0.10	5.89	0.00	0
1992	2869	5959	287	0	287	0.00	0.21	0.10	4.82	0.00	0
1993	2995	3104	103	0	103	0.00	0.10	0.03	3.32	0.00	0
1994	3032	2165	64	1	63	1.56	0.07	0.02	2.96	0.05	0
1995(P)	3095	26015	30	3	27	10.0	0.84	0.01	0.12	0.01	0

20. District : Bhagalpur

1985											
1986	2871	42791	216	0	216	0.00	1.49	0.08	0.50	0.00	0
1987	2995	48703	277	5	272	1.81	1.63	0.09	0.57	0.01	0
1988	2995	41621	148	3	145	2.03	1.39	0.05	0.36	0.01	0
1989	3055	45995	117	6	111	5.13	1.51	0.04	0.25	0.01	0
1990	3116	44133	197	2	195	1.02	1.42	0.06	0.45	0.00	0
1991	3198	38355	147	2	145	1.36	1.20	0.05	0.38	0.01	0
1992	3341	32762	132	3	129	2.27	0.98	0.04	0.40	0.01	0
1993	3414	28100	91	2	89	2.20	0.82	0.03	0.32	0.01	0
1994	3489	26003	52	2	50	3.85	0.75	0.01	0.20	0.01	0
1995(P)	3562										

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

21. District : Munger

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3658	36344	404	88	316	21.78	0.99	0.11	1.11	0.24	0
1987	2962	25121	97	2	95	2.06	0.85	0.03	0.39	0.01	0
1988	2962	16391	331	33	298	9.97	0.55	0.11	2.02	0.20	0
1989	3021	28569	609	386	223	63.38	0.95	0.20	2.13	1.35	0
1990	3081	28971	522	239	283	45.79	0.94	0.17	1.80	0.82	0
1991	3055	25976	1048	457	591	43.61	0.85	0.34	4.03	1.76	0
1992	2152	13174	36	0	36	0.00	0.61	0.02	0.27	0.00	0
1993	2195	12309	58	0	58	0.00	0.56	0.03	0.47	0.00	0
1994	2238	11847	93	0	93	0.00	0.53	0.04	0.79	0.00	0
1995											

22. District : Khagaria

1985	New district created in 1987										
1986											
1987	826	14690	297	8	289	2.69	1.78	0.36	2.02	0.05	0
1988	826	920	45	17	28	37.78	0.11	0.05	4.89	1.85	0
1989	842	4933	104	0	104	0.00	0.59	0.12	2.11	0.00	0
1990	862	6311	90	0	90	0.00	0.73	0.10	1.43	0.00	0
1991	987	6172	87	0	87	0.00	0.63	0.09	1.41	0.00	0
1992	1043	3718	32	0	32	0.00	0.36	0.03	0.86	0.00	0
1993	1072	2915	53	0	53	0.00	0.27	0.05	1.82	0.00	0
1994	1102	3414	24	0	24	0.00	0.31	0.02	0.70	0.00	0
1995											

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

23. District : Begusarai

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1608	29438	52	10	42	19.23	1.83	0.03	0.18	0.03	0
1987	1664	24443	40	0	40	0.00	1.47	0.02	0.16	0.00	0
1988	1664	20407	7	0	7	0.00	1.23	0.00	0.03	0.00	0
1989	1697	24156	7	0	7	0.00	1.42	0.00	0.03	0.00	0
1990	1731	23672	4	0	4	0.00	1.37	0.00	0.02	0.00	0
1991	1813	21215	4	0	4	0.00	1.17	0.00	0.02	0.00	0
1992	1901	17549	6	2	4	33.33	0.92	0.00	0.03	0.01	0
1993	1947	18799	18	1	17	5.56	0.97	0.01	0.10	0.01	0
1994	1994	17032	11	0	11	0.00	0.85	0.01	0.06	0.00	0
1995											

24. District : Purnia

1985											
1986	3965	95548	161	15	146	9.32	2.41	0.04	0.17	0.02	0
1987	4108	98853	146	5	141	3.42	2.41	0.04	0.15	0.01	0
1988	4108	83997	57	4	53	7.02	2.04	0.01	0.07	0.00	0
1989	4190	91306	62	3	59	4.84	2.18	0.01	0.07	0.00	0
1990	4274	76533	43	3	40	6.98	1.79	0.01	0.06	0.00	0
1991	4477	67194	105	1	104	0.95	1.50	0.02	0.16	0.00	0
1992	4694	50104	24	0	24	0.00	1.07	0.05	0.05	0.00	0
1993	4810	46326	21	0	21	0.00	0.96	0.04	0.05	0.00	2
1994	4903	40870	16	0	16	0.00	0.83	0.00	0.04	0.00	0
1995(P)	2098	13636	22	0	22	0.00	0.64	0.01	0.16	0.00	0

25. District : Katihar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1575	20807	15	0	15	0.00	1.32	0.01	0.07	0.00	0
1987	1632	15861	9	0	9	0.00	0.97	0.01	0.06	0.00	0
1988	1647	14114	4	0	4	0.00	0.86	0.00	0.03	0.00	0
1989	1665	19125	8	0	8	0.00	1.15	0.00	0.04	0.00	0
1990	1698	14634	6	0	6	0.00	0.86	0.00	0.04	0.00	0
1991	1822	11959	1	0	1	0.00	0.66	0.00	0.01	0.00	0
1992	1921	9952	6	0	6	0.00	0.52	0.00	0.06	0.00	0
1993	1973	8789	0	0	0	0.00	0.45	0.00	0.00	0.00	0
1994	2026	7652	1	1	0	100.00	0.38	0.00	0.01	0.01	0
1995(P)	2068	9761	1	0	0	0.00	0.47	0.00	0.01	0.00	0

26. District : Saharsa

1985											
1986	3259	89788	550	6	544	1.09	2.76	0.17	0.61	0.01	0
1987	2328	46267	301	4	297	1.33	1.99	0.13	0.65	0.01	0
1988	2328	32337	65	2	63	3.08	1.39	0.03	0.20	0.01	0
1989	2375	37720	96	0	96	0.00	1.59	0.04	0.25	0.00	0
1990	2423	39417	132	1	131	0.76	1.63	0.05	0.33	0.00	0
1991	2515	36489	81	1	80	1.23	1.45	0.03	0.22	0.00	0
1992	2515	20188	58	0	58	0.00	0.80	0.02	0.29	0.00	0
1993	2716	24070	7	0	7	0.00	0.89	0.02	0.03	0.00	0
1994	2789	19637	17	0	17	0.00	0.70	0.01	0.09	0.00	0
1995(P)	1296	10537	22	0	22	0.00	0.81	0.02	0.21	0.00	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

27. District :Madhepura

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1987										
1986											
1987	1046	27637	16	0	16	0.00	2.64	0.02	0.06	0.00	0
1988	1163	29579	12	0	12	0.00	2.54	0.01	0.04	0.00	0
1989	1067	34126	26	0	26	0.00	3.20	0.02	0.08	0.00	0
1990	1088	32425	16	0	16	0.00	2.98	0.01	0.05	0.00	0
1991	1178	35105	15	0	15	0.00	2.98	0.01	0.04	0.00	0
1992	1230	20137	12	0	12	0.00	1.64	0.01	0.06	0.00	0
1993		N.A									
1994	1285	23833	11	0	11	0.00	1.85	0.01	0.05	0.00	0
1995(P)	1311	22570	29	0	29	0.00	1.72	0.02	0.13	0.00	0

28. District :Dumka

1985	New Distt. created in 1987										
1986											
1987	1383	64215	1282	531	751	41.42	4.64	0.93	2.00	0.83	0
1988	4257	188786	3405	917	2488	26.93	4.43	0.80	1.80	0.49	0
1989	1411	50779	1924	432	1492	22.45	3.60	1.36	3.79	0.85	0
1990	1439	58354	2852	458	2394	16.06	4.06	1.98	4.89	0.78	0
1991	1497	53180	2484	313	2171	12.60	3.55	1.66	4.67	0.59	0
1992	1567	46192	2297	153	2126	6.66	2.95	1.47	4.97	0.33	0
1993	1603	49701	2547	113	2434	4.44	3.10	1.59	5.12	0.23	0
1994	1640	45494	2403	157	2246	6.53	2.77	1.47	5.28	0.35	0
1995(P)	1674	35117	4277	215	4062	5.02	2.09	2.55	12.18	0.61	0

Note : Information on Sahebganj, Godda & Deogpur districts included here.

29. District : Sahebganj

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1987										
1986											
1987	1238	80267	632	355	277	56.17	6.48	0.51	0.79	0.44	0
1988	Information included in Dumka district										
1989	1263	52317	580	325	255	56.03	4.14	0.46	1.11	0.62	0
1990	1288	60003	1233	250	983	20.28	4.66	0.96	2.05	0.42	0
1991	1297	53202	543	41	502	7.55	4.10	0.42	1.02	0.08	0
1992	1350	36632	312	135	177	43.27	2.71	0.23	0.85	0.37	0
1993	1397	42225	1597	202	1395	12.65	3.02	1.14	3.78	0.48	0
1994	1404	19278	178	127	51	71.35	1.37	0.13	0.92	0.66	0
1995(P)	1433	16444	202	135	67	66.83	1.14	0.14	1.23	0.82	0

30. District : Godda

1985	New Distt. created in 1987										
1986											
1987	815	49899	611	204	407	33.39	6.12	0.75	1.22	0.41	0
1988		Information included in Dumka district									
1989	832	43791	678	266	412	39.23	5.26	0.81	1.55	0.61	0
1990	848	49896	2024	387	1637	19.12	5.88	2.39	4.06	0.78	0
1991	857	46290	684	47	437	36.11	5.40	0.80	1.48	0.53	0
1992	893	39537	624	287	337	45.99	4.43	0.70	1.58	0.73	0
1993	911	32922	1290	364	926	28.22	3.61	1.42	3.92	1.11	0
1994	929	29074	781	367	414	46.99	3.13	0.84	2.69	1.26	0
1995(P)	948	19507	650	334	316	51.38	2.05	0.69	3.33	1.71	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

31. District : Deoghar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt.created in 1987										
1986											
1987	810	18687	23	2	21	8.70	2.31	0.03	0.12	0.01	0
1988		Information included in Dumka district.									
1989	827	20681	23	0	23	0.00	2.50	0.03	0.11	0.00	0
1990	843	9753	119	6	113	5.04	1.16	0.14	1.22	0.06	0
1991	918	17386	54	5	49	9.26	1.89	0.06	0.31	0.03	0
1992	972	23900	281	1	280	0.36	2.46	0.29	1.18	0.00	0
1993	1001	26279	265	1	264	0.38	2.63	0.26	1.01	0.00	0
1994	1032	21241	118	0	118	0.00	2.06	0.11	0.56	0.00	0
1995 (P)	1053	9717	295	0	295	0.00	0.92	0.28	3.04	0.00	0

32. District : Ranchi

1985											
1986	3377	180433	7235	5794	1441	80.08	5.34	2.14	4.01	3.21	0
1987	1927	98296	1683	1399	284	83.12	5.49	0.84	1.54	1.42	0
1988											
1989	1965	79520	1623	1243	380	76.59	4.05	0.83	2.04	1.56	0
1990	2004	77300	2017	1612	405	79.92	3.86	1.01	2.61	2.09	0
1991	2214	67868	2752	2055	697	74.67	3.07	1.24	4.05	3.03	0
1992	2295	54930	2317	1573	744	67.89	2.39	1.01	4.22	2.86	0
1993	2340	46591	2112	1781	331	84.33	1.99	0.90	4.53	3.82	0
1994	2386	34165	2185	1801	384	82.43	1.43	0.92	6.40	5.27	0
1995											

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

33. District : Gumla

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1987										
1986											
1987	1242	83619	2511	2203	308	87.73	6.73	2.02	3.00	2.63	0
1988	1198	86902	4446	4123	323	92.74	7.25	3.71	5.12	4.74	0
1989	1099	121057	12392	11501	891	92.81	11.02	11.28	10.24	9.50	0
1990	1125	92367	12875	11962	913	92.91	8.21	11.44	13.94	12.95	0
1991	1154	98827	18230	15497	2733	85.01	8.56	15.80	18.45	15.68	8
1992	1184	91675	16747	14416	2331	86.08	7.74	14.14	18.27	15.73	0
1993	1199	96234	17028	15177	1851	89.13	8.03	14.20	17.69	15.77	0
1994	1217	100861	15441	14045	1396	90.96	8.29	12.69	15.31	13.93	0
1995											

34. District : Lohardaga

1985	New Distt. created in 1987										
1986											
1987	338	19170	1151	720	431	62.55	5.67	3.41	6.00	3.76	0
1988	295	17422	1014	544	470	53.65	5.91	3.44	5.82	3.12	0
1989	277	22073	2402	1545	857	64.32	7.97	8.67	10.88	7.00	0
1990	283	20274	1208	796	412	65.89	7.16	4.27	5.96	3.93	0
1991	289	18283	1505	1022	483	67.91	6.33	5.21	8.23	5.59	0
1992	304	13214	1405	948	457	67.47	4.35	4.62	10.63	7.17	0
1993	312	11364	809	441	368	54.51	3.64	2.5	7.12	3.88	0
1994	319	11889	932	559	373	59.98	3.73	2.92	7.8	4.70	0
1995											

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

35. District : Singhbhum

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3156	219548	17590	13853	3705	78.75	6.96	5.57	8.01	6.31	0
1987	3269	189119	12823	10507	2316	81.94	5.79	3.92	6.78	5.56	0
1988	3269	77951	5125	4210	905	82.15	2.38	1.57	6.57	5.40	0
1989	3335	159305	12503	11051	1452	88.39	4.78	3.75	7.85	6.94	0
1990	3401	174615	13881	12428	1453	89.53	5.13	4.08	7.95	7.12	9
1991	3407	131969	9652	8695	957	90.08	3.87	2.83	7.31	6.59	12
1992	3535	170458	14233	12224	2009	85.88	4.82	4.03	8.35	7.17	0
1993	3600	164547	16302	14201	2101	87.11	4.57	4.53	9.91	8.63	0
1994	3674	175912	19371	16815	2556	86.81	4.79	5.27	11.01	9.56	12
1995(P)	1767	63925	10036	8697	1339	86.65	3.61	5.68	15.70	13.61	0

36. District : Palamu

1985											
1986	2115	115427	8390	4465	3925	53.22	5.46	3.97	7.27	3.87	0
1987	2178	116180	7587	3463	4124	45.64	5.33	3.48	6.53	2.98	0
1988											
1989	2234	127499	8111	4111	4000	50.68	5.71	3.63	6.36	3.22	0
1990	2279	127539	9704	4690	5014	48.33	5.60	4.26	7.61	3.68	0
1991	2451	127416	10140	4999	5141	49.30	5.20	4.14	7.96	3.92	0
1992	2590	115030	10244	5396	4848	52.67	4.44	3.96	8.91	4.69	0
1993	2662	189964	16488	8718	7770	52.87	7.14	6.19	8.68	4.59	0
1994	2736	168872	15890	6768	9122	42.59	6.17	5.81	9.41	4.01	0
1995(P)	1837	115114	13857	9306	4551	67.15	6.26	7.54	12.04	8.08	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

37. District : Hazaribagh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2239	180834	1116	297	819	26.61	8.08	0.50	0.62	0.16	0
1987	2307	151295	1111	509	602	45.81	6.56	0.48	0.73	0.34	0
1988	2307	151463	1949	618	1331	31.71	6.57	0.84	1.29	0.41	0
1989	2353	128408	3491	1860	1631	53.28	5.46	1.48	2.72	1.45	1
1990	2410	132956	5159	3156	2003	61.17	5.52	2.14	3.88	2.37	0
1991	2468	108285	5586	3422	2164	61.26	4.39	2.26	5.16	3.16	1
1992	2839	126729	7133	4266	2867	59.81	4.46	2.51	5.63	3.37	0
1993	2511	104545	6909	3981	2928	57.62	4.16	2.75	6.6	3.81	0
1994	2584	78859	4668	2721	1947	58.29	3.05	1.81	5.92	3.45	0
1995(P)	2638	68793	5924	3903	2021	65.88	2.60	2.25	8.61	5.67	0

38. District : Giridih

1985											
1986	1606	95501	686	367	319	53.50	5.95	0.43	0.72	0.38	0
1987	1652	86756	669	348	321	52.02	5.25	0.40	0.77	0.40	0
1988	1814	73741	573	239	334	41.71	4.07	0.32	0.78	0.32	0
1989	1685	72510	1630	1231	399	75.52	4.30	0.97	2.25	1.70	0
1990	1718	73177	2064	1206	858	58.43	4.26	1.20	2.82	1.65	0
1991	2224	57350	2317	1465	852	63.23	2.58	1.04	4.0	2.55	0
1992	2350	64755	3610	2060	1550	57.06	2.76	1.54	5.57	3.18	0
1993	2416	58731	2737	1703	1034	62.22	2.43	1.13	4.66	2.89	0
1994	2488	68259	2408	1452	956	60.30	2.74	0.97	3.53	2.13	0
1995(P)	2540	60506	2834	1959	87 5	69.12	2.38	1.12	4.68	3.24	0

BIHAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

39. District : Dhanbad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1539	25776	536	56	480	10.45	1.67	0.35	2.08	0.22	0
1987	1590	25242	551	45	506	8.17	1.59	0.35	2.18	0.18	0
1988	1590	22371	391	247	144	63.17	1.41	0.25	1.75	1.10	0
1989	1622	33076	915	640	275	69.95	2.04	0.56	2.77	1.93	0
1990	1654	31249	1066	416	650	39.02	1.89	0.64	3.41	1.33	0
1991	2709	27161	1031	168	863	16.29	1.00	0.38	3.80	0.62	0
1992	2863	22857	584	77	507	13.18	0.80	0.20	2.56	0.34	0
1993	2943	27883	1277	211	1066	16.52	0.95	0.43	4.58	0.76	0
1994	3026	30856	1685	301	1384	17.86	1.02	0.56	5.46	0.98	0
1995											

GOA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Goa

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1263	73275	433	2	431	0.46	5.80	0.34	0.59	0.00	0
1987	1263	108001	4814	16	4798	0.33	8.55	3.81	4.46	0.01	0
1988	1181	128955	6732	287	6445	4.26	10.92	5.70	5.22	0.22	0
1989	1181	100310	4197	566	3631	13.49	8.49	3.55	4.18	0.56	0
1990	1181	99687	4890	871	4019	17.81	8.44	4.14	4.91	0.87	0
1991	1181	85211	2879	499	2380	17.33	7.22	2.44	3.38	0.59	0
1992	1181	79094	848	202	646	23.82	6.70	0.72	1.07	0.26	0
1993	1181	91439	2227	333	1894	14.95	7.74	1.89	2.44	0.36	0
1994	1181	101003	3456	275	3181	7.96	8.55	2.93	3.42	0.27	0
1995(P)	1205	93378	3886	256	3630	6.59	7.75	3.22	4.16	0.27	0

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

1. District : Ahemedabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	4196	376204	20456	3053	17403	14.92	8.97	4.88	5.44	0.81	0
1987	4249	396547	12839	630	12209	4.91	9.33	3.02	3.24	0.16	0
1988	4385	467718	13796	4898	8898	35.50	10.67	3.15	2.95	1.05	0
1989	4297	435629	26920	8918	18002	33.13	10.14	6.26	6.18	2.05	0
1990	4298	423103	23929	5457	18472	22.80	9.84	5.57	5.66	1.29	0
1991	4298	432896	22667	7773	14894	34.29	10.07	5.27	5.24	1.80	0
1992	4317	443273	11856	2907	8949	24.52	10.27	2.75	2.67	0.66	0
1993	4317	341156	6960	1668	5292	23.97	18.78	3.83	2.04	0.49	0
1994	5154	512275	10077	3546	6531	35.19	9.94	1.96	1.97	0.69	8
1995											

2. District : Kheda

1985											
1986	3272	554657	7834	1407	6427	17.96	16.95	2.39	1.41	0.25	0
1987	3272	813092	16376	2262	14114	13.81	24.85	5.00	2.01	0.28	0
1988	3328	861508	27845	11362	16483	40.80	25.89	8.37	3.23	1.32	0
1989	3336	587351	27271	8251	19020	30.26	17.61	8.17	4.64	1.40	0
1990	3387	793465	31867	7147	24720	22.43	23.43	9.41	4.02	0.90	0
1991	3400	634373	27910	9308	18602	33.35	18.66	8.21	4.40	1.47	0
1992	3412	720796	29228	6945	22283	23.76	21.13	8.57	4.05	0.96	0
1993	3419	658653	25246	4815	20431	19.07	19.26	7.38	3.83	0.73	0
1994	3588	667352	26840	6071	20769	22.62	18.60	7.48	4.02	0.91	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

3. District : Surendra Nagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	1121	101124	7774	1107	6667	14.24	9.02	6.93	7.69	1.09	0
1987	1156	110917	6200	480	5720	7.74	9.59	5.36	5.59	0.43	0
1988	1182	195501	30227	6958	23269	23.02	16.54	25.57	15.46	3.56	0
1989	1182	195840	39236	9320	29916	23.75	16.57	33.19	20.03	4.76	0
1990	1189	222130	26599	3826	22773	14.38	18.68	22.37	11.97	1.72	0
1991	1301	187420	14232	2695	11537	18.94	14.41	10.94	7.59	1.44	0
1992	1169	239550	12831	2140	10691	16.68	20.49	10.98	5.36	0.89	0
1993	1301	229135	11740	1963	9777	16.72	17.61	9.02	5.12	0.86	0
1994	1271	283401	14806	3019	11787	20.39	22.30	11.65	5.22	1.07	0
1995											

4. District : Gandhi Nagar

1985											
1986	332	49814	1101	89	1012	8.08	15.00	3.32	2.21	0.18	0
1987	340	51968	642	28	614	4.36	15.28	1.89	1.24	0.05	0
1988	349	62304	1595	552	1043	34.61	17.85	4.57	2.56	0.89	0
1989	357	68576	6406	1106	5300	17.27	19.21	17.94	9.34	1.61	0
1990	366	84791	4872	621	4251	12.75	23.17	13.31	5.75	0.73	0
1991	378	57880	1898	344	1554	18.12	15.31	5.02	3.28	0.59	0
1992	416	69564	1814	288	1526	15.88	16.72	4.36	2.61	0.41	0
1993	416	66544	1468	243	1225	16.00	16.00	3.53	2.21	0.37	0
1994	418	72118	1325	260	1065	19.62	17.25	3.17	1.84	0.36	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

5. District : Mehsana

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	2841	402861	2906	246	2660	8.47	14.18	1.02	0.72	0.06	0
1987	2841	443958	2500	113	2387	4.52	15.63	0.88	0.56	0.03	0
1988	2862	521430	5536	865	4671	15.63	18.22	1.93	1.06	0.17	0
1989	2906	505898	11928	2184	9744	18.31	17.41	4.10	2.36	0.43	0
1990	2951	587363	13214	1753	11461	13.27	19.90	4.48	2.25	0.30	0
1991	2995	484338	10378	1996	8382	19.23	16.17	3.47	2.14	0.41	0
1992	2755	482609	7314	989	6325	13.52	17.52	2.65	1.52	0.20	0
1993	2995	496407	7208	1109	6099	15.39	16.57	2.41	1.45	0.22	0
1994	3074	551872	7693	2093	5600	27.21	17.95	2.50	1.39	0.38	0
1995											

6. District : Sabarkantha

1985											
1986	1656	294011	713	226	487	31.70	17.75	0.43	0.24	0.08	0
1987	1674	375600	4182	662	3520	15.83	22.44	2.50	1.11	0.18	0
1988	1700	458641	20028	8317	11711	41.53	26.98	11.78	4.37	1.81	0
1989	1720	457384	21425	6451	14974	30.11	26.59	12.46	4.68	1.41	0
1990	1746	506371	10006	2546	7460	25.44	29.00	5.73	1.98	0.50	0
1991	1890	439311	11826	3571	8255	30.20	23.24	6.26	2.69	0.81	0
1992	1909	489630	14443	4068	10375	28.17	25.65	7.57	2.95	0.83	0
1993	1920	528471	16948	4386	12562	25.88	27.52	8.83	3.21	0.83	0
1994	1854	500099	11681	2781	8900	23.81	26.97	6.30	2.34	0.56	1
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

7. District : Banaskantha

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	1867	241584	1551	307	1244	19.79	12.94	0.83	0.64	0.13	0
1987	1914	276517	1582	131	1451	8.28	14.45	0.83	0.57	0.05	0
1988	1970	327025	10838	2792	8046	25.76	16.60	5.50	3.31	0.85	0
1989	2019	362659	20310	3993	16317	19.66	17.96	10.06	5.60	1.10	0
1990	2070	407205	23201	5303	17898	22.86	19.67	11.21	5.70	1.30	0
1991	2099	306723	13479	1923	11556	14.27	14.61	6.42	4.39	0.63	0
1992	2148	338609	7575	1609	5966	21.24	15.76	3.53	2.24	0.48	0
1993	2192	357974	5335	1021	4314	19.14	16.33	2.43	1.49	0.29	0
1994	2360	404164	10951	3142	7809	28.69	17.13	4.64	2.71	0.78	0
1995											

8. District : Vadodara

1985											
1986	2617	340331	13454	3196	10258	23.76	13.00	5.14	3.95	0.94	0
1987	2667	451144	39799	11362	28437	28.55	16.92	14.92	8.82	2.52	0
1988	2667	538072	55096	17641	37455	32.02	20.18	20.66	10.24	3.28	0
1989	2667	576713	73906	22988	50918	31.10	21.62	27.71	12.82	3.99	0
1990	2887	559050	51710	16784	34926	32.46	19.36	17.91	9.25	3.00	0
1991	2887	560764	43523	14489	29034	33.29	19.42	15.08	7.76	2.58	0
1992	2887	511079	29493	6584	22909	22.32	17.70	10.22	5.77	1.29	0
1993	2887	514166	23867	5762	18105	24.14	17.81	8.27	4.64	1.12	0
1994	3286	514482	20334	5107	15227	25.12	15.66	6.19	3.95	0.99	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

9. District : Panchmahal

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	2611	319475	6835	2093	4742	30.62	12.24	2.62	2.14	0.66	0
1987	2670	455685	32116	8866	23250	27.61	17.07	12.03	7.05	1.95	0
1988	2682	603081	62479	22655	39824	36.26	22.49	23.30	10.36	3.76	0
1989	2775	550451	79815	22035	57780	27.61	19.84	28.76	14.50	4.00	0
1990	2844	547069	67883	12717	55166	18.73	19.24	23.87	12.41	2.32	0
1991	2922	517341	62307	13814	48493	22.17	17.71	21.32	12.04	2.67	0
1992	2992	484164	51653	10504	41149	20.34	16.18	17.26	10.67	2.17	0
1993	3039	559458	52176	11168	41008	21.40	18.41	17.17	9.33	2.00	0
1994	3205	462381	33399	4840	28559	14.49	14.43	10.42	7.22	1.05	0
1995											

10. District : Bharuch

1985											
1986	1398	190600	14042	3415	10627	24.32	13.63	10.04	7.37	1.79	0
1987	1398	255690	24599	5751	18848	23.38	18.29	17.60	9.62	2.25	0
1988	1398	311022	28160	5855	22305	20.79	22.25	20.14	9.05	1.88	0
1989	1398	298896	34158	6649	27509	19.47	21.38	24.43	11.43	2.22	0
1990	1362	335347	38532	7718	30814	20.03	24.62	28.29	11.49	2.30	0
1991	1403	300754	30517	6245	24272	20.46	21.44	21.75	10.15	2.08	0
1992	1447	336088	26080	4139	21941	15.87	23.23	18.02	7.76	1.23	0
1993	1543	321872	18799	3374	15425	17.95	20.86	12.18	5.84	1.05	0
1994	1637	296748	11514	1655	9859	14.37	18.13	7.03	3.88	0.56	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

11. District : Surat

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	2536	277959	36090	13549	22541	37.54	10.96	14.23	12.98	4.87	0
1987	2776	377862	70477	32060	38417	45.49	13.61	25.39	18.65	8.48	0
1988	2776	492048	101692	47941	53751	47.14	17.73	36.63	20.67	9.74	0
1989	3113	419525	99044	44653	54391	45.08	13.48	31.82	23.61	10.64	0
1990	3143	489020	98118	51293	46825	52.28	15.56	31.22	20.06	10.49	0
1991	3426	519302	86481	45219	41262	52.29	15.16	25.24	16.65	8.71	0
1992	3421	613309	89298	41162	48136	46.10	17.93	26.10	14.56	6.71	0
1993	3485	581282	70628	27076	43552	38.34	16.68	20.27	12.15	4.66	0
1994	3780	549309	44241	17685	26556	39.97	14.53	11.70	8.05	3.22	0
1995											

12. District : Valsad

1985											
1986	1863	264980	14883	2391	12492	16.07	14.22	7.99	5.62	0.90	0
1987	1993	371938	41169	9991	31178	24.27	18.66	20.66	11.07	2.69	0
1988	2027	363482	59893	17566	42327	29.33	17.93	29.55	16.48	4.83	0
1989	2061	280764	42278	10067	32211	23.81	13.62	20.51	15.06	3.59	0
1990	2097	262170	20025	5413	14612	27.03	12.50	9.55	7.64	2.06	0
1991	2097	306251	16223	4858	11365	29.95	14.60	7.74	5.30	1.59	0
1992	2178	356614	12687	4165	8522	32.83	16.37	5.83	3.56	1.17	0
1993	2267	374932	14446	4221	10225	29.22	16.54	6.37	3.85	1.13	0
1994	2324	338602	8766	1982	6784	22.61	14.57	3.77	2.59	0.59	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

13. District : Dangs

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	123	14608	156	34	122	21.79	11.88	1.27	1.07	0.23	0
1987	124	24703	4683	1620	3063	34.59	19.92	37.77	18.96	6.56	0
1988	131	27409	4855	1126	3729	23.19	20.92	37.06	17.71	4.11	0
1989	131	25001	3881	864	3017	22.26	19.08	29.63	15.52	3.46	0
1990	147	20938	2233	394	1939	17.64	14.24	15.19	10.66	1.88	0
1991	147	22825	2921	496	2425	16.98	15.53	19.87	12.80	2.17	0
1992	147	28245	2622	453	2169	17.28	19.21	17.84	9.28	1.60	0
1993	147	30291	2120	358	1762	16.89	20.61	14.42	7.00	1.18	0
1994	156	33985	1562	205	1357	13.12	21.79	10.01	4.60	0.60	0
1995											

14. District : Rajkot

1985											
1986	2135	206370	7106	1099	6007	15.47	9.67	3.33	3.44	0.53	0
1987	2208	248357	4850	650	4200	13.40	11.25	2.20	1.95	0.26	0
1988	2240	283633	12268	4175	8093	34.03	12.66	5.48	4.33	1.47	0
1989	2249	345034	28329	9010	19319	31.80	15.34	12.60	8.21	2.61	0
1990	2449	320243	25363	3616	21747	14.26	13.08	10.36	7.92	1.13	0
1991	2449	327667	17078	1879	15199	11.00	13.38	6.97	5.21	0.57	0
1992	2495	358741	13147	1636	11511	12.44	14.38	5.27	3.66	0.46	0
1993	2449	359696	10126	1455	8671	14.37	14.69	4.13	2.82	0.40	0
1994	2669	377733	9880	1675	8205	16.95	14.15	3.70	2.62	0.44	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

15. District : Jamnagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	1489	113111	3010	38	2972	1.26	7.60	2.02	2.66	0.03	0
1987	1494	128876	2169	25	2144	1.15	8.63	1.45	1.68	0.02	0
1988	1528	154308	3889	478	3411	12.29	10.10	2.55	2.52	0.31	0
1989	1559	180465	6475	2070	4405	31.97	11.58	4.15	3.59	1.15	0
1990	1599	197220	7164	984	6180	13.74	12.33	4.48	3.63	0.50	0
1991	1636	192936	3612	362	3250	10.02	11.79	2.21	1.87	0.19	0
1992	1636	228597	2975	224	2751	7.53	13.97	1.82	1.30	0.10	0
1993	1636	225429	1747	265	1482	15.17	13.78	1.07	0.77	0.12	0
1994	1621	216482	2788	433	2355	15.53	13.35	1.72	1.29	0.20	0
1995											

16. District : Kutchh

1995											
1986	1122	128725	2013	369	1644	18.33	11.47	1.79	1.56	0.29	0
1987	1140	139898	1304	189	1115	14.49	12.27	1.14	0.93	0.14	0
1988	1166	197652	7537	2214	5323	29.38	16.95	6.46	3.81	1.12	0
1989	1272	283122	41375	14403	26972	34.81	22.26	32.53	14.61	5.09	0
1990	1316	203708	25931	4832	21099	18.63	15.48	19.70	12.73	2.37	0
1991	1316	141586	8392	994	7398	11.84	10.76	6.38	5.93	0.70	0
1992	1316	205272	10754	4841	5913	45.02	15.60	8.17	5.24	2.36	0
1993	1316	180586	7343	2282	5061	31.08	13.72	5.58	4.07	1.26	0
1994	1368	220158	14269	6393	7876	44.80	16.09	10.43	6.48	2.90	4
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

17. District : Bhavnagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	1890	200029	1956	444	1512	22.70	10.58	1.03	0.98	0.22	0
1987	1890	252268	1235	143	1092	11.58	13.35	0.65	0.49	0.06	0
1988	2254	341543	2247	720	1527	32.04	15.15	1.00	0.66	0.21	0
1989	2254	243101	6904	2310	4594	33.46	10.79	3.06	2.84	0.95	0
1990	2346	265143	7669	2330	5339	30.38	11.30	3.27	2.89	0.88	0
1991	2465	259554	4146	1490	2656	35.94	10.53	1.68	1.60	0.57	0
1992	2542	300444	3826	1490	2336	38.94	11.82	1.51	1.27	0.50	0
1993	2465	301878	2702	633	2069	23.43	12.25	1.10	0.90	0.21	0
1994	2446	310351	2686	873	1813	32.50	12.69	1.10	0.87	0.28	1
1995											

18. District : Amreli

1985											
1986	1169	131178	6314	816	5498	12.92	11.22	5.40	4.81	0.62	0
1987	1231	143513	4548	631	3917	13.87	11.66	3.69	3.17	0.44	0
1988	1242	182049	8818	2381	6437	27.00	14.66	7.10	4.84	1.31	0
1989	1272	194331	15288	3183	12105	20.82	15.28	12.02	7.87	1.64	0
1990	1331	255530	16185	3471	12714	21.45	19.20	12.16	6.33	1.36	0
1991	1337	253253	13558	2464	11094	18.17	18.94	10.14	5.35	0.97	0
1992	1370	244296	10074	1785	8289	17.72	17.83	7.35	4.12	0.73	0
1993	1337	243869	7709	1444	6265	18.73	18.24	5.77	3.16	0.59	0
1994	1314	238979	6830	1287	5543	18.84	18.19	5.20	2.86	0.54	0
1995											

GUJARAT - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

19. District : Junagadh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	2262	211100	5368	1024	4344	19.08	9.33	2.37	2.54	0.49	0
1987	2296	228384	3323	564	2759	16.97	9.95	1.45	1.46	0.25	0
1988	2385	278578	3884	790	3094	20.34	11.68	1.63	1.39	0.28	0
1989	2459	317117	13704	6723	6981	49.06	12.90	5.57	4.32	2.12	0
1990	2472	326866	21425	6702	14723	31.28	13.22	8.67	6.55	2.05	0
1991	2472	290759	13587	2919	10668	21.48	11.76	5.50	4.67	1.00	0
1992	2473	322966	10862	2284	8578	21.03	13.06	4.39	3.36	0.71	0
1993	2505	330074	13654	3858	9796	28.26	13.18	5.45	4.14	1.17	0
1994	2597	311329	8982	2332	6650	25.96	11.99	3.46	2.89	0.75	0
1995											

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Ambala

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	1608	302487	2398	57	2341	2.38	18.81	1.49	0.79	0.02	0
1987	1643	294682	935	15	920	1.60	17.94	0.57	0.32	0.01	0
1988	1686	312158	425	10	415	2.35	18.51	0.25	0.14	0.00	0
1989	1719	317253	2278	15	2263	0.66	18.46	1.33	0.72	0.00	0
1990	1079	229430	3983	64	3919	1.61	21.26	3.69	1.74	0.03	0
1991	1114	203244	2748	4	2744	0.15	18.24	2.47	1.35	0.00	0
1992	1153	176198	713	12	701	1.68	15.28	0.62	0.40	0.01	0
1993	1228	142505	693	3	690	0.43	11.60	0.56	0.49	0.00	0
1994	1242	165130	492	17	475	3.46	13.30	0.40	0.30	0.01	0
1995(P)	1268	168135	1441	66	1375	4.58	13.26	1.14	0.86	0.04	0

2. District : Bhiwani

1985											
1986	1117	196034	9351	430	8921	4.60	17.55	8.37	4.77	0.22	0
1987	1136	203476	3424	41	3383	1.20	17.91	3.01	1.68	0.02	0
1988	1157	222997	1154	73	1081	6.33	19.27	1.00	0.52	0.03	0
1989	1179	188493	1733	32	1701	1.85	15.99	1.47	0.92	0.02	0
1990	1201	195995	3778	286	3492	7.57	16.32	3.15	1.93	0.15	0
1991	1264	168527	2808	199	2609	7.09	13.33	2.22	1.67	0.12	0
1992	1195	148420	1328	178	1150	13.40	12.42	1.11	0.89	0.12	0
1993	1205	151047	2883	273	2610	9.47	12.54	2.39	1.91	0.18	0
1994	1227	145100	4298	526	3772	12.24	11.83	3.50	2.96	0.36	0
1995(P)	1252	187976	8164	1116	7048	13.67	15.01	6.52	4.34	0.59	0

N. B. Population decreased became of taking away CHC-Miran to Hissar district.

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Faridabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1395	221444	5394	390	5004	7.23	15.87	3.87	2.44	0.18	0
1987	1429	221052	2020	95	1925	4.70	15.47	1.41	0.91	0.04	0
1988	1484	262951	2056	434	1622	21.11	17.72	1.39	0.78	0.17	0
1989	1553	247827	1805	236	1569	13.07	15.96	1.16	0.73	0.10	0
1990	1600	226873	3061	682	2379	22.28	14.18	1.91	1.35	0.30	0
1991	1640	189259	2055	261	1794	12.70	11.54	1.25	1.09	0.14	0
1992	1664	182591	668	203	465	30.39	10.97	0.40	0.37	0.11	0
1993	1677	166472	722	145	577	20.08	9.93	0.43	0.43	0.09	0
1994	1742	170495	979	196	783	20.02	9.79	0.56	0.57	0.11	0
1995(P)	1778	172749	1339	325	1014	24.27	9.72	0.75	0.78	0.19	0

4. District : Gurgaon

1985											
1986	1040	141090	1136	68	1068	5.99	13.57	1.09	0.81	0.05	0
1987	1085	138184	186	18	168	9.68	12.74	0.17	0.13	0.01	0
1988	1114	149907	403	84	319	20.84	13.46	0.36	0.27	0.06	0
1989	1152	139326	628	81	547	12.90	12.09	0.55	0.45	0.06	0
1990	1185	155019	3888	1752	2136	45.06	13.08	3.28	2.51	1.13	0
1991	1232	124420	2363	444	1919	18.79	10.10	1.92	1.90	0.36	0
1992	1268	103363	911	125	786	13.72	8.15	0.72	0.88	0.12	0
1993	1268	97824	810	62	748	7.65	7.71	0.64	0.83	0.06	0
1994	1298	121335	3074	1180	1894	38.39	9.35	2.37	2.53	0.97	0
1995(P)	1325	140925	3348	773	2575	23.09	10.64	2.53	2.38	0.55	0

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : Hissar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1744	261754	11125	372	10753	3.34	15.01	6.38	4.25	0.14	0
1987	1789	239619	2253	33	2220	1.46	13.39	1.26	0.94	0.01	0
1988	1837	226993	520	26	494	5.00	12.36	0.28	0.23	0.01	0
1889	1885	181959	1182	32	1150	2.71	9.65	0.63	0.65	0.02	0
1990	1920	182513	3312	78	3234	2.36	9.51	1.73	1.81	0.04	0
1991	1964	185405	2364	15	2349	0.63	9.44	1.20	1.28	0.01	0
1992	2111	184515	2498	35	2463	1.40	8.74	1.18	1.35	0.02	0
1993	2114	203762	3950	42	3908	1.06	9.64	1.87	1.94	0.02	0
1994	2158	223822	3755	111	3644	2.96	10.37	1.74	1.68	0.05	0
1995(P)	2203	224672	5862	1019	4771	18.61	10.20	2.66	2.61	0.49	0

6. District : Jind

1985											
1986	1112	198310	5171	131	5040	2.53	17.83	4.65	2.61	0.07	0
1987	1125	189800	2023	5	2018	0.25	16.87	1.80	1.07	0.00	0
1988	1156	208800	1068	39	1029	3.65	18.06	0.92	0.51	0.02	0
1989	1177	194637	1118	18	1100	1.61	16.54	0.95	0.57	0.01	0
1990	1025	159564	1190	6	1184	0.50	15.57	1.16	0.75	0.00	0
1991	1049	146636	742	3	739	0.40	13.98	0.71	0.51	0.00	0
1992	1094	141773	546	12	534	2.20	12.96	0.50	0.39	0.01	0
1993	1107	144464	691	13	678	1.88	13.05	0.62	0.48	0.01	0
1994	1121	146556	809	35	774	4.33	13.07	0.72	0.55	0.02	0
1995(P)	1144	175936	2592	436	2156	16.82	15.38	2.27	1.47	0.25	0

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Kaithal

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. Created in 1990										
1986											
1987											
1988											
1989											
1990	855	152210	2660	10	2650	0.38	17.80	3.11	1.75	0.01	0
1991	875	115628	1021	14	1007	1.37	13.21	1.17	0.88	0.01	0
1992	855	92056	569	6	563	1.05	10.77	0.67	0.62	0.01	0
1993	872	108114	508	12	496	2.36	12.40	0.58	0.47	0.01	0
1994	878	126029	797	65	732	8.16	14.35	0.91	0.63	0.05	0
1995(P)	896	157871	2533	1242	1291	49.03	17.62	2.83	1.60	0.79	0

8. District : Karnal

1985											
1986	1584	271469	4026	119	3907	2.96	17.14	2.54	1.48	0.04	0
1987	1606	256095	1288	3	1285	0.23	15.95	0.80	0.50	0.00	0
1988	1608	261488	345	19	326	5.51	16.26	0.21	0.13	0.01	0
1989	1715	260517	2440	52	2388	2.13	15.19	1.42	0.94	0.02	0
1990	894	176480	8191	137	8054	1.67	19.74	9.16	4.64	0.08	0
1991	903	165462	6569	11	6558	0.17	18.32	7.27	3.97	0.01	0
1992	1079	150059	2487	121	2366	4.87	13.91	2.30	1.66	0.08	0
1993	1084	153518	2561	42	2519	1.64	14.16	2.36	1.67	0.03	0
1994	1120	197812	4461	675	3786	15.13	17.66	3.98	2.26	0.34	0
1995(P)	1143	219554	10067	2050	8017	20.36	19.21	8.81	4.59	0.93	0

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : Kurukshetra

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1307	194160	854	21	833	2.46	14.86	0.65	0.44	0.01	0
1987	1342	214365	445	3	442	0.67	15.97	0.33	0.21	0.00	0
1988	1378	223596	519	5	514	0.96	16.23	0.38	0.23	0.00	0
1989	1401	243464	5543	34	5509	0.61	17.38	3.96	2.28	0.01	0
1990	668	117913	2903	27	2876	0.93	17.65	4.35	2.46	0.02	0
1991	682	103922	1786	6	1780	0.34	15.24	2.62	1.72	0.01	0
1992	692	84037	662	5	657	0.76	12.14	0.96	0.79	0.01	0
1993	704	89761	363	1	362	0.28	12.75	0.52	0.40	0.00	0
1994	725	92144	336	12	324	3.57	12.71	0.46	0.36	0.01	0
1995(P)	740	94119	561	53	508	9.45	12.72	0.76	0.60	0.06	0

10. District : Narnaul

1985											
1986	1155	203437	4031	86	3945	2.13	17.61	3.49	1.98	0.04	0
1987	1178	202250	1303	3	1300	0.23	17.17	1.11	0.64	0.00	0
1988	1207	199027	1278	68	1210	5.32	16.49	1.06	0.64	0.03	0
1989	1230	167959	2613	86	2527	3.29	13.66	2.12	1.56	0.05	0
1990	714	100275	2468	132	2336	5.35	14.04	3.46	2.46	0.13	0
1991	732	93227	1425	41	1384	2.88	12.74	1.95	1.53	0.04	0
1992	746	95830	739	61	678	8.25	12.85	0.99	0.77	0.06	0
1993	748	103636	828	12	816	1.45	13.86	1.11	0.80	0.01	0
1994	759	85541	857	104	753	12.14	11.27	1.13	1.00	0.12	0
1995(P)	774	85909	1305	79	1226	6.05	11.10	1.69	1.52	0.09	0

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Panipat

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985	New Distt. Created in 1990										
1986											
1987											
1988											
1989											
1990	815	122533	2880	43	2837	1.49	15.03	3.53	2.35	0.04	0
1991	846	117989	1972	7	1965	0.35	13.95	2.33	1.67	0.01	0
1992	682	69675	1008	19	989	1.88	10.22	1.48	1.45	0.03	0
1993	720	69025	1432	8	1424	0.56	9.59	1.99	2.07	0.01	0
1994	741	81726	1640	26	1614	1.59	11.03	2.21	2.01	0.03	0
1995(P)	756	100326	1998	166	1832	8.31	13.27	2.64	1.99	0.17	0

12. District : Rewari

1985	New Distt. Created in1990										
1986											
1987											
1988											
1989											
1990	649	79568	687	11	676	1.60	12.26	1.06	0.86	0.01	0
1991	662	68761	335	3	332	0.90	10.39	0.51	0.49	0.00	0
1992	670	67572	360	5	355	1.39	10.09	0.54	0.53	0.01	0
1993	671	65428	270	7	263	2.59	9.75	0.40	0.41	0.01	0
1994	696	61464	438	239	199	54.57	8.83	0.63	0.71	0.39	0
1995(P)	710	61256	383	41	342	10.70	8.63	0.54	0.63	0.07	0

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

13. District : Rohtak

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1986	1615	250262	5324	68	5256	1.28	15.50	3.30	2.13	0.03	0
1987	1657	234831	1247	12	1235	0.96	14.17	0.75	0.53	0.01	0
1988	1687	250364	873	37	836	4.24	14.84	0.52	0.35	0.01	0
1989	1724	239976	1428	42	1386	2.94	13.92	0.83	0.60	0.02	0
1990	1726	285103	4165	280	3885	6.72	16.51	2.41	1.46	0.10	0
1991	1732	211222	2208	93	2115	4.21	12.20	1.27	1.05	0.04	0
1992	1744	208863	1241	333	908	26.83	11.98	0.71	0.59	0.16	0
1993	1700	202130	2392	315	2077	13.17	11.89	1.41	1.18	0.16	0
1994	1716	195649	3768	280	3488	7.43	11.40	2.20	1.93	0.14	0
1995(P)	1752	220374	11552	2307	9245	19.97	12.58	6.59	5.24	1.05	0

14. District : Sirsa

1985											
1986	814	197269	12651	550	12101	4.35	24.23	15.54	6.41	0.28	0
1987	844	186366	3636	43	3593	11.18	22.08	4.31	1.95	0.02	0
1988	860	157624	494	34	460	6.88	18.33	0.57	0.31	0.02	0
1989	883	136817	659	9	650	1.37	15.49	0.75	0.48	0.01	0
1990	904	121705	1385	37	1348	2.67	13.46	1.53	1.14	0.03	0
1991	936	108138	845	5	840	0.59	11.55	0.90	0.78	.00	0
1992	950	105494	1389	47	1342	3.38	11.10	1.46	1.32	0.04	0
1993	959	104047	1696	24	1672	1.42	10.85	1.77	1.63	0.02	0
1994	981	141529	1898	39	1859	2.05	14.43	1.93	1.34	0.03	0
1995(P)	1001	129301	1926	32	1894	1.66	12.92	1.92	1.49	0.02	0

HARYANA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

15. District : Sonepat

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1041	154802	1114	47	1067	4.22	14.87	1.07	0.72	0.03	0
1987	1061	152392	166	2	164	1.20	14.36	0.16	0.11	0.00	0
1988	1087	154123	102	9	93	8.82	14.18	0.09	0.07	0.01	0
1989	1101	155951	2284	41	2243	1.80	14.16	2.07	1.46	0.03	0
1990	1118	117346	3228	53	3175	1.64	10.49	2.88	2.75	0.05	0
1991	1134	145602	3288	33	3255	1.00	12.84	2.90	2.26	0.02	0
1992	1152	131034	1008	67	941	6.65	11.37	0.87	0.77	0.05	0
1993	1112	127649	1772	25	1747	1.41	11.48	1.59	1.39	0.02	0
1994	1131	144970	2010	189	1821	9.40	12.82	1.78	1.39	0.13	0
1995(P)	1154	162781	5403	1049	4354	19.42	14.11	4.68	3.32	0.64	0

16. District : Yamunanagar

1985	New Distt. Created in 1990										
1986											
1987											
1988											
1989											
1990	811	134997	2602	19	2583	0.73	16.65	3.21	1.93	0.01	0
1991	827	127437	1482	3	1479	0.20	15.41	1.79	1.16	0.00	0
1992	846	117170	535	9	526	1.68	13.85	0.63	0.46	0.01	0
1993	871	85267	461	1	460	0.22	9.79	0.53	0.54	0.00	0
1994	887	103032	198	7	191	3.54	11.62	0.22	0.19	0.01	0
1995(P)	905	105145	639	2	637	0.31	11.62	0.71	0.61	0.00	0

HIMACHAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

1. District : Bilaspur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	273	45082	2192	16	2176	0.73	16.51	8.03	4.86	0.04	0
1987	283	45969	1203	13	1190	1.08	16.24	4.25	2.62	0.03	0
1988	284	48068	522	0	522	0.00	16.93	1.84	1.09	0.00	0
1989	289	51752	577	0	577	0.00	17.91	2.00	1.11	0.00	0
1990	298	55948	1178	3	1175	0.25	18.77	3.95	2.11	0.01	0
1991	304	59865	1733	0	1733	0.00	19.69	5.70	2.89	0.00	0
1992	311	59157	740	2	738	0.27	19.02	2.38	1.25	0.00	0
1993	316	61755	396	0	396	0.00	19.54	1.25	0.64	0.00	0
1994	326	56493	407	2	405	0.49	17.33	1.25	0.72	0.00	0
1995(P)	317	50442	671	1	670	0.15	15.91	2.12	1.33	0.00	0

2. District : Chamba

1985											
1986	205	35689	2726	3	2723	0.11	17.41	13.30	7.64	0.01	0
1987	214	26449	802	1	801	0.12	12.36	3.75	3.03	0.00	0
1988	206	25095	299	1	298	0.33	12.18	1.45	1.19	0.00	0
1989	213	30222	385	1	384	0.26	14.19	1.81	1.27	0.00	0
1990	229	21066	413	1	412	0.24	9.20	1.80	1.96	0.00	0
1991	264	24013	464	2	462	0.43	9.10	1.76	1.93	0.01	0
1992	267	24936	137	0	137	0.00	9.34	0.51	0.55	0.00	0
1993	373	24507	35	0	35	0.00	6.57	0.09	0.14	0.00	0
1994	276	23792	65	1	64	1.54	8.62	0.24	0.27	0.00	0
1995 (P)	279	22743	163	2	161	1.23	8.15	0.58	0.72	0.01	0

3. District : Hamirpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	359	74411	1994	20	1974	1.00	20.73	5.55	2.68	0.03	0
1987	371	74882	924	2	922	0.22	20.18	2.49	1.23	0.00	0
1988	375	80066	205	5	200	2.44	21.35	0.55	0.26	0.01	0
1989	382	60866	327	5	322	1.53	15.93	0.86	0.54	0.01	0
1990	387	69826	729	3	726	0.41	18.04	1.88	1.04	0.00	0
1991	388	78853	1020	0	1020	0.00	20.32	2.63	1.29	0.00	0
1992	390	71727	333	0	333	0.00	18.39	0.85	0.46	0.00	0
1993	394	72025	832	0	832	0.00	18.28	2.11	1.16	0.00	0
1994	398	65152	242	0	242	0.00	16.37	0.61	0.37	0.00	0
1995(P)	401	70840	444	0	444	0.00	17.67	1.11	0.63	0.00	0

4. District : Kangra

1985											
1986	1055	192263	12921	181	12740	1.40	18.22	12.25	6.72	0.09	0
1987	1069	201806	6765	26	6739	0.38	18.88	6.33	3.35	0.01	0
1988	1085	214618	2227	18	2209	0.81	19.78	2.05	1.04	0.01	0
1989	1096	202853	1950	1	1949	0.05	18.51	1.78	0.96	0.00	0
1990	1112	189961	4243	8	4235	0.19	17.08	3.82	2.23	0.00	0
1991	1124	194116	5135	1	5134	0.02	17.27	4.57	2.65	0.00	0
1992	1135	186972	1290	2	1288	0.16	16.47	1.14	0.69	0.00	0
1993	1150	171532	832	0	832	0.00	14.92	0.72	0.49	0.00	0
1994	1159	150757	1010	3	1007	0.30	13.01	0.87	0.67	0.00	0
1995(P)	1174	134874	2243	6	2237	0.27	11.49	1.91	1.66	0.00	0

HIMACHAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

5. District : Kullu

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	87	21375	533	0	533	0.00	24.57	6.13	2.49	0.00	0
1987	97	22617	329	0	329	0.00	23.32	3.39	1.45	0.00	0
1988	89	21721	152	0	152	0.00	24.41	1.71	0.70	0.00	0
1989	90	21993	161	1	160	0.62	24.44	1.79	0.73	0.00	0
1990	92	25036	324	1	323	0.31	27.21	3.52	1.29	0.00	0
1991	93	27199	414	0	414	0.00	29.25	4.45	1.52	0.00	0
1992	95	29188	305	0	305	0.00	30.72	3.21	1.04	0.00	0
1993	97	25753	209	0	209	0.00	26.55	2.15	0.81	0.00	0
1994	99	26703	179	0	179	0.00	26.97	1.81	0.67	0.00	0
1995(P)	102	29612	324	0	324	0.00	29.03	3.18	1.09	0.00	0

6. District : Mandi

1985											
1986	612	67662	2523	18	2505	0.71	11.06	4.12	3.73	0.03	0
1987	628	73484	966	0	966	0.00	11.70	1.54	1.31	0.00	0
1988	636	74032	426	1	425	0.23	11.64	0.67	0.58	0.00	0
1989	660	92512	434	0	434	0.00	14.02	0.66	0.47	0.00	0
1990	683	90504	1223	4	1219	0.33	13.25	1.79	1.35	0.00	0
1991	691	91108	1666	0	1666	0.00	13.18	2.41	1.83	0.00	0
1992	698	96896	948	1	947	0.11	13.88	1.36	0.98	0.00	0
1993	715	96051	566	0	566	0.00	13.43	0.79	0.59	0.00	0
1994	718	86055	305	0	305	0.00	11.99	0.42	0.35	0.00	0
1995(P)	743	91888	639	1	638	0.16	12.37	0.86	0.70	0.00	0

HIMACHAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

7. District : Shimla

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	122	44365	1423	3	1420	0.21	36.36	11.66	3.21	0.01	0
1987	125	47872	640	11	629	1.72	38.30	5.12	1.34	0.02	0
1988	128	39364	370	8	362	2.16	30.75	2.89	0.94	0.02	0
1989	130	40176	321	2	319	0.62	30.90	2.47	0.80	0.00	0
1990	132	41285	689	0	689	0.00	31.28	5.22	1.67	0.00	0
1991	135	42371	843	0	843	0.00	31.39	6.24	1.99	0.00	0
1992	138	39776	226	0	226	0.00	28.82	1.64	0.57	0.00	0
1993	140	36445	157	0	157	0.00	26.03	1.12	0.43	0.00	0
1994	142	27686	108	0	108	0.00	19.50	0.76	0.39	0.00	0
1995(P)	147	23582	229	0	229	0.00	16.04	1.56	0.97	0.00	0

8. District : Sirmour

1985											
1986	322	60134	6354	6	6248	0.09	18.68	19.73	10.57	0.01	0
1987	329	50885	2548	0	2548	0.00	15.47	7.74	5.01	0.00	0
1988	334	46479	1601	1	1600	0.06	13.92	4.79	3.44	0.00	0
1989	342	49033	1831	2	1829	0.10	14.34	5.35	3.73	0.00	0
1990	376	52060	2205	5	2200	0.23	13.85	5.86	4.24	0.01	0
1991	355	59809	4039	0	4039	0.00	16.85	11.38	6.75	0.00	0
1992	349	54600	1914	3	1911	0.16	15.64	5.48	3.51	0.01	0
1993	349	46060	1145	0	1145	0.00	13.20	3.28	2.49	0.00	0
1994	356	40472	342	0	342	0.00	11.37	0.96	0.85	0.00	0
1995(P)	362	38974	786	3	783	0.38	10.77	2.17	2.02	0.01	0

HIMACHAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

9. District : Solan

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	315	86604	7069	18	7051	0.25	27.49	22.44	8.16	0.02	0
1987	320	86957	5966	3	5963	0.05	27.17	18.64	6.86	0.00	0
1988	329	86410	3682	4	3678	0.11	26.26	11.19	4.26	0.00	0
1989	334	85146	1992	1	1991	0.05	25.49	5.96	2.34	0.00	0
1990	343	77560	2342	2	2340	0.09	22.61	6.83	3.02	0.00	0
1991	349	77975	3490	2	3488	0.06	22.34	10.00	4.48	0.00	0
1992	366	76733	942	0	942	0.00	20.97	2.57	1.23	0.00	0
1993	373	73042	303	0	303	0.00	19.58	0.81	0.41	0.00	0
1994	381	68350	213	0	213	0.00	17.94	0.56	0.31	0.00	0
1995(P)	386	7272 8	537	0	537	0.00	18.84	1.39	0.74	0.00	0

10. District : Una

1985											
1986	359	57301	4401	59	4342	1.34	15.96	12.26	7.68	0.10	0
1987	359	62619	2317	9	2308	0.39	17.44	6.45	3.70	0.01	0
1988	364	65200	725	3	722	0.41	17.91	1.99	1.11	0.00	0
1989	385	58694	611	1	610	0.16	15.25	1.59	1.04	0.00	0
1990	376	58541	1033	3	1030	0.29	15.57	2.75	1.76	0.01	0
1991	395	69222	1311	0	1311	0.00	17.52	3.32	1.89	0.00	0
1992	375	63316	416	1	415	0.24	16.88	1.11	0.66	0.00	0
1993	381	58758	192	1	191	0.52	15.42	0.50	0.33	0.00	0
1994	388	52089	220	0	220	0.00	13.43	0.57	0.42	0.00	0
1995(P)	395	58161	659	0	659	0.00	14.72	1.67	1.13	0.00	0

JAMMU & KASHMIR - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

1. District : Jammu

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1054	171753	15402	443	14959	2.88	16.30	14.61	8.97	0.26	0
1987	1054	127043	4382	26	4356	0.59	12.05	4.16	3.45	0.02	0
1988	1080	131600	1720	44	1676	2.56	12.19	1.59	1.31	0.03	0
1989	1080	105318	847	16	831	1.89	9.75	0.78	0.80	0.02	0
1990	1128	122527	2360	73	2287	3.09	10.86	2.09	1.93	0.06	0
1991	1132	116502	2246	4	2242	0.18	10.29	1.98	1.93	0.00	0
1992	1324	100225	479	6	473	1.25	7.57	0.36	0.48	0.01	0
1993	1392	100483	175	6	169	3.43	7.22	0.13	0.17	0.01	0
1994	1353	111452	1326	33	1293	2.49	8.24	0.98	1.19	0.03	0
1995(P)	1265	120510	4730	27	4703	0.57	9.53	3.74	3.92	0.02	0

2. District : Kathua

1985											
1986	397	108748	12580	1605	10975	12.76	27.39	31.69	11.57	1.48	0
1987	397	70932	3654	173	3481	4.73	17.87	9.20	5.15	0.24	0
1988	397	78087	1631	324	1307	19.87	19.67	4.11	2.09	0.41	0
1989	429	72061	979	72	907	7.35	16.80	2.28	1.36	0.10	0
1990	437	74272	1364	125	1239	9.16	17.00	3.12	1.84	0.17	0
1991	457	63265	1186	4	1182	0.34	13.84	2.60	1.87	0.01	0
1992	457	51232	287	4	283	1.39	11.21	0.63	0.56	0.01	0
1993	470	51791	98	1	97	1.02	11.02	0.21	0.19	0.00	0
1994	480	55125	409	3	406	0.73	11.48	0.85	0.74	0.01	0
1995(P)	495	66695	740	3	737	0.41	13.47	1.49	1.11	0.00	0

3. District : Udhampur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	497	84195	10763	13	10750	0.12	16.94	21.66	12.78	0.02	0
1987	502	83476	1877	5	1872	0.27	16.63	3.74	2.25	0.01	0
1988	508	85826	281	10	271	3.56	16.89	0.55	0.33	0.01	0
1989	528	81128	325	12	313	3.69	15.37	0.62	0.40	0.01	0
1990	539	72054	942	25	917	2.65	13.37	1.75	1.31	0.03	0
1991	580	65473	578	1	577	0.17	11.29	1.00	0.88	0.00	0
1992	593	56560	148	1	147	0.68	9.54	0.25	0.26	0.00	0
1993	604	62672	186	3	183	1.61	10.38	0.31	0.30	0.00	0
1994	612	67790	418	6	412	1.44	11.08	0.68	0.62	0.01	0
1995(P)	621	76021	1646	3	1643	0.18	12.24	2.65	2.17	0.00	0

4. District : Rajouri

1985											
1986	331	61632	2249	1	2248	0.04	18.62	6.79	3.65	0.00	0
1987	341	44608	1188	1	1187	0.08	13.08	3.48	2.66	0.00	0
1988	345	38906	469	0	469	0.00	11.28	1.36	1.21	0.00	0
1989	345	42702	576	0	576	0.00	12.38	1.67	1.35	0.00	0
1990	363	43847	419	0	419	0.00	12.08	1.15	0.96	0.00	0
1991	364	37231	374	0	374	0.00	10.23	1.03	1.00	0.00	0
1992	382	29908	189	0	189	0.00	7.83	0.49	0.63	0.00	0
1993	421	37102	202	0	202	0.00	8.81	0.48	0.54	0.00	0
1994	427	50894	447	2	445	0.45	11.92	1.05	0.88	0.00	0
1995(P)	438	55108	1565	1	1564	0.06	12.58	3.57	2.84	0.00	0

5. District : Poonch

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	237	24642	321	0	321	0.00	10.40	1.35	1.30	0.00	0
1987	251	29959	299	1	298	0.33	11.94	1.19	1.00	0.00	0
1988	270	33202	268	0	268	0.00	12.30	0.99	0.81	0.00	0
1989	272	33129	263	1	262	0.38	12.18	0.97	0.79	0.00	0
1990	289	39642	307	0	307	0.00	13.72	1.06	0.77	0.00	0
1991	295	33276	187	1	186	0.53	11.28	0.63	0.56	0.00	0
1992	301	26594	85	0	85	0.00	8.84	0.28	0.32	0.00	0
1993	301	30420	107	2	105	1.87	10.11	0.36	0.35	0.01	0
1994	304	29481	122	0	122	0.00	9.70	0.40	0.41	0.00	0
1995(P)	307	29758	241	1	240	0.41	9.69	0.79	0.81	0.00	0

6. District : Doda

1985											
1986	470	14355	489	1	488	0.20	3.05	1.04	3.41	0.01	0
1987	490	19723	132	0	132	0.00	4.03	0.27	0.67	0.00	0
1988	490	16798	56	0	56	0.00	3.43	0.11	0.33	0.00	0
1989	510	14881	65	0	65	0.00	2.92	0.13	0.44	0.00	0
1990	510	20108	86	0	86	0.00	3.94	0.17	0.43	0.00	0
1991	510	19969	84	1	83	1.19	3.92	0.16	0.42	0.01	0
1992	519	12427	56	0	56	0.00	2.39	0.11	0.45	0.00	0
1993	519	12615	16	0	16	0.00	2.43	0.03	0.13	0.00	0
1994	523	16253	38	4	34	10.53	3.11	0.07	0.23	0.02	0
1995(P)	523	24893	83	4	79	4.82	4.76	0.16	0.33	0.02	0

7. District : Baramulla

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	70	1110	11	0	11	0.00	1.59	0.16	0.99	0.00	0
1987	70	1730	4	0	4	0.00	2.47	0.06	0.23	0.00	0
1988	70	1409	5	0	5	0.00	2.01	0.07	0.35	0.00	0
1989	70	705	7	0	7	0.00	1.07	0.10	0.93	0.00	0
1990	70	566	3	0	3	0.00	0.81	0.04	0.53	0.00	0
1991	70	529	1	0	1	0.00	0.76	0.01	0.19	0.00	0
1992	70	437	0	0	0	0.00	0.62	0.00	0.00	0.00	0
1993	70	402	0	0	0	0.00	0.57	0.00	0.00	0.00	0
1994	70	630	0	0	0	0.00	0.90	0.00	0.00	0.00	0
1995											

8. District : Kupwara

1985											
1986	24	526	0	0	0	0.00	2.19	0.00	0.00	0.00	0
1987	24	118	4	0	4	0.00	0.49	0.17	3.39	0.00	0
1988											
1989											
1990											
1991											
1992											
1993											
1994											
1995											

KARNATAKA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Bangalore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	4300	387098	51	9	42	17.65	9.00	0.01	0.01	0.00	0
1987	4922	419754	112	3	109	2.68	8.53	0.02	0.03	0.00	0
1988	3998	428122	99	8	91	8.08	10.71	0.02	0.02	0.00	0
1989	2870	421908	220	25	195	11.36	14.70	0.08	0.05	0.01	0
1990	2865	442465	222	31	191	13.96	15.44	0.07	0.05	0.01	0
1991	2941	489138	273	83	190	30.40	16.63	0.09	0.06	0.02	5
1992	2959	516658	643	180	463	27.99	17.46	0.21	0.12	0.03	0
1993	3210	483537	663	203	460	30.62	15.06	0.21	0.14	0.04	0
1994	3102	518434	831	206	625	24.78	16.71	0.26	0.16	0.03	0
1995	3167	373686	972	324	648	33.33	11.80	0.31	0.26	0.09	0

2. District : Kolar

1985											
1986	1899	425431	1042	377	665	36.18	22.40	0.55	0.24	0.09	0
1987	1927	383121	1202	444	758	36.94	19.88	0.62	0.31	0.12	0
1988	1927	413813	2261	1487	774	65.77	21.47	1.17	0.55	0.36	0
1989	1962	419653	9381	5817	3564	62.01	21.39	4.78	2.24	1.39	0
1990	2001	423835	23778	12204	11574	51.32	21.18	11.88	5.61	2.88	0
1991	2111	364885	10844	2155	8689	19.87	17.28	5.14	2.97	0.59	0
1992	2111	419308	29586	7043	22543	23.81	19.86	14.01	7.06	1.68	0
1993	2211	395464	23830	3808	20022	15.98	17.89	10.78	6.03	0.96	0
1994	2211	385707	19200	3736	15464	19.46	17.44	8.68	4.98	0.97	1
1995	2257	227802	11095	2504	8591	22.57	10.09	4.92	4.87	1.10	0

KARNATAKA - Districtwise & Yearwise Epidemological Data & Parameters (1985 - 1995)

3. District : Shimoga

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1657	224398	67	1	66	1.49	13.54	0.04	0.03	0.00	0
1987	1658	254933	80	12	68	15.00	15.38	0.05	0.03	0.00	0
1988	1980	278470	97	7	90	7.22	14.06	0.05	0.03	0.00	0
1989	1759	262440	120	17	103	14.17	14.92	0.07	0.05	0.01	0
1990	1759	259292	89	9	80	10.11	14.74	0.05	0.03	0.00	0
1991	1517	269662	20	2	18	10.00	17.78	0.01	0.01	0.00	0
1992	1949	277970	160	6	154	3.75	14.26	0.08	0.06	0.00	0
1993	1949	294745	547	68	479	12.43	15.12	0.28	0.19	0.02	0
1994	1963	285770	1624	106	1518	6.53	14.56	0.83	0.57	0.04	0
1995	2004	263726	2553	91	2462	3.56	13.16	1.27	0.97	0.03	0

4. District : Chitradurga

1985											
1986	1982	350951	2373	474	1899	19.97	17.71	1.20	0.68	0.14	0
1987	2117	411057	13968	3746	10222	26.82	19.42	6.60	3.40	0.91	0
1988	2127	494787	31627	10508	21119	33.22	23.26	14.87	6.39	2.12	0
1989	1747	478748	20358	4648	15710	22.83	27.40	11.65	4.25	0.97	0
1990	1801	427522	4859	732	4127	15.06	23.74	2.70	1.14	0.17	0
1991	1843	429185	1452	201	1251	13.84	23.29	0.79	0.34	0.05	0
1992	1865	445210	5680	247	5433	4.35	23.87	3.05	1.28	0.06	0
1993	1872	443209	21248	2197	19051	10.34	23.68	11.35	4.79	0.50	0
1994	1807	462972	35472	3164	32308	8.92	25.62	19.63	7.66	0.68	0
1995	1844	392203	19837	1698	18139	8.56	21.27	10.76	5.06	0.43	0

KARNATAKA - Districtwise & Yearwise Epidemological Data & Parameters (1985 - 1995)

5. District : Tumkur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2040	337275	4460	489	3971	10.96	16.53	2.19	1.32	0.14	0
1987	2095	415119	6115	1146	4969	18.74	19.81	2.92	1.47	0.28	0
1988	2278	523518	12349	3586	8763	29.03	22.98	5.42	2.35	0.68	0
1989	2278	456633	10969	2509	8460	22.87	20.05	4.82	2.40	0.55	0
1990	2324	454268	12683	3305	9378	26.06	19.55	5.46	2.79	0.73	0
1991	2360	478515	7054	1923	5131	27.26	20.28	2.99	1.47	0.40	0
1992	2324	459419	8024	2280	5744	28.41	19.77	3.45	1.75	0.50	0
1993	2358	506058	40618	17559	23059	43.23	21.46	17.23	8.03	3.47	0
1994	2370	456863	34798	8092	26706	23.25	19.28	14.68	7.62	1.77	1
1995(P)	2419	295005	14515	1604	12911	11.05	12.20	6.00	4.92	0.54	0

6. District : Belgaum

1985											
1986	2994	400295	1168	193	975	16.52	13.37	0.39	0.29	0.05	0
1987	2997	418445	1252	231	1021	18.45	13.96	0.42	0.30	0.06	0
1988	3034	419522	2066	607	1459	29.38	13.83	0.68	0.49	0.14	0
1989	3044	399846	1576	541	1035	34.33	13.14	0.52	0.39	0.14	0
1990	3168	411401	879	377	502	42.89	12.99	0.28	0.21	0.09	0
1991	3461	395912	633	154	479	24.33	11.44	0.18	0.16	0.04	0
1992	3258	434719	1490	432	1058	28.99	13.34	0.46	0.34	0.10	0
1993	3318	402936	574	120	454	20.91	12.14	0.17	0.14	0.03	0
1994	3328	382729	399	95	304	23.81	11.50	0.12	0.10	0.02	0
1995	3397	350539	700	69	631	9.86	10.32	0.21	0.20	0.02	0

KARNATAKA - Districtwise & Yearwise Epidemological Data & Parameters (1985 - 1995)

7. District : Bijapur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2536	468715	16847	4723	12124	28.03	18.48	6.64	3.59	1.01	0
1987	2570	532192	15968	4037	11931	25.28	20.71	6.21	3.00	0.76	0
1988	2767	573583	18714	4987	13727	26.65	20.73	6.76	3.26	0.87	0
1989	2767	529789	14180	2064	12116	14.56	19.15	5.12	2.68	0.39	0
1990	2767	523356	8072	1978	6094	24.50	18.91	2.92	1.54	0.38	0
1991	2746	494457	5326	1351	3975	25.37	18.01	1.94	1.08	0.27	1
1992	2799	482210	4905	1028	3877	20.96	17.23	1.75	1.02	0.21	0
1993	2797	443056	3924	848	3076	21.61	15.84	1.40	0.89	0.19	0
1994	2854	447272	7486	1769	5717	23.63	15.67	2.62	1.67	0.40	1
1995	2913	403856	8591	3625	4966	42.20	13.86	2.95	2.13	0.90	0

8. District : Dharwar

1985											
1986	2940	272372	84	2	81	2.38	9.26	0.03	0.03	0.00	0
1987	2940	393797	137	14	123	10.22	13.39	0.05	0.03	0.00	0
1988	2940	489034	462	49	413	10.61	16.63	0.16	0.09	0.01	0
1989	2527	455595	655	88	567	13.44	18.03	0.26	0.14	0.02	0
1990	2572	461234	616	146	470	23.70	17.93	0.24	0.13	0.03	0
1991	2556	490559	584	44	540	7.53	19.19	0.23	0.12	0.01	0
1992	2545	502872	1142	54	1088	4.73	19.76	0.45	0.23	0.01	0
1993	2603	525737	782	15	767	1.92	20.20	0.30	0.15	0.00	0
1994	2667	558831	802	32	770	3.99	20.95	0.30	0.14	0.01	0
1995	2723	491201	1093	92	1001	8.42	18.04	0.40	0.22	0.02	0

KARNATAKA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

9. District : Karwar (UK)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1071	149237	33	1	32	3.03	13.93	0.03	0.02	0.00	0
1987	1071	182001	49	5	44	10.20	16.99	0.05	0.03	0.00	0
1988	1235	197620	70	9	61	12.86	16.00	0.06	0.04	0.00	0
1989	1001	218486	171	4	167	2.34	21.83	0.17	0.08	0.00	0
1990	1001	200894	82	3	79	3.66	20.07	0.08	0.04	0.00	0
1991	1001	187018	37	2	35	5.41	18.68	0.04	0.02	0.00	0
1992	1003	191657	120	9	111	7.50	19.11	0.12	0.06	0.00	0
1993	1013	186243	88	6	82	6.82	18.39	0.09	0.05	0.00	0
1994	1021	188639	995	31	964	3.12	18.48	0.97	0.53	0.02	0
1995											

10. District : Gulburga

1985											
1986	2394	315730	22066	8555	13511	38.77	13.19	9.21	6.98	2.71	0
1987	2337	302385	21522	10300	11222	47.86	12.94	6.65	7.12	3.41	0
1988	2337	262549	11294	4390	6904	38.87	11.23	4.83	4.30	1.67	5
1989	2337	302634	10382	2946	7436	28.38	12.95	4.44	3.43	0.97	0
1990	2397	314454	3673	770	2903	20.96	13.12	1.53	1.17	0.24	0
1991	2448	293180	2536	448	2088	17.67	11.98	1.04	0.86	0.15	0
1992	2573	296140	2806	549	2257	19.57	11.51	1.09	0.95	0.19	0
1993	2573	287582	2815	648	2167	23.02	11.18	1.09	0.98	0.23	0
1994	2573	251125	3065	965	2100	31.48	9.76	1.19	1.22	0.38	0
1995 (P)	2627	230685	3990	1017	2973	25.49	8.78	1.52	1.73	0.44	0

KARNATAKA - Districtwise & Yearwise & Epidemological Data & Parameters (1985 - 1995)

11. District : Bidar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1078	166158	521	25	496	4.80	15.41	0.48	0.31	0.02	0
1987	1094	188526	489	29	460	5.93	17.23	0.45	0.26	0.02	0
1988	1140	169562	450	41	409	9.11	14.87	0.39	0.27	0.02	0
1989	1124	151983	431	51	380	11.83	13.52	0.38	0.28	0.03	0
1990	1132	145921	637	110	527	17.27	12.89	0.56	0.44	0.08	0
1991	1138	164121	1081	412	669	38.11	14.42	0.95	0.66	0.25	1
1992	1214	200296	1764	373	1391	21.15	16.50	1.45	0.88	0.19	0
1993	1289	228197	2472	469	2003	18.97	17.70	1.92	1.08	0.21	0
1994	1308	203376	2388	492	1896	20.60	15.55	1.83	1.17	0.24	0
1995	1335	187565	2106	515	1591	24.45	14.05	1.58	1.12	0.27	0

12. District : Bellary

1985											
1986	1583	305661	443	135	308	30.47	19.31	0.28	0.14	0.04	0
1987	1638	301705	2139	455	1684	21.27	18.42	1.31	0.71	0.15	0
1988	1638	289119	4029	770	3259	19.11	17.65	2.46	1.39	0.27	0
1989	1696	269155	7318	2206	5112	30.14	15.87	4.31	2.72	0.82	0
1990	1696	256341	4142	811	3331	19.58	15.11	2.44	1.62	0.32	0
1991	1696	279002	2562	665	1897	25.96	16.45	1.51	0.92	0.24	0
1992	1713	274932	2473	238	2235	9.62	16.05	1.44	0.90	0.09	0
1993	1776	272707	3357	147	3210	4.38	15.36	1.89	1.23	0.05	0
1994	1776	263449	3351	180	4171	5.37	14.83	1.89	1.27	0.07	0
1995(P)	1813	160814	12245	150	12095	1.22	8.87	6.75	7.61	0.09	0

KARNATAKA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

13. District : Raichur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1858	349573	2096	631	1465	30.10	18.81	1.13	0.60	0.18	0
1987	1883	397276	16549	7370	9179	44.53	21.10	8.79	4.17	1.86	0
1988	1920	450305	28834	7064	21770	24.50	23.45	15.02	6.40	1.57	3
1989	1938	467239	18112	6268	11844	34.61	24.11	9.35	3.88	1.34	0
1990	1977	416845	4013	1053	2960	26.24	21.08	2.03	0.96	0.25	0
1991	2044	390308	1342	332	1010	24.74	19.10	0.66	0.34	0.09	0
1992	2091	393914	1566	304	1262	19.41	18.84	0.75	0.40	0.08	0
1993	2137	395799	1619	398	1221	24.58	18.52	0.76	0.41	0.10	0
1994	2323	417676	8099	1983	6116	24.48	17.98	3.49	1.94	0.47	0
1995(P)	2371	341565	7426	1893	5533	25.49	14.41	3.13	2.17	0.55	0

14. District : UKP Naryanpur

1985											
1986	20	38677	2304	870	1434	37.76	193.39	115.20	5.96	2.25	0
1987	20	53177	2589	1234	1355	47.66	265.89	129.45	4.87	2.32	0
1988	20	72360	5823	2368	3455	40.67	361.80	291.15	8.05	3.27	0
1989	58	59288	3923	1099	2824	28.01	102.22	67.64	6.62	1.85	0
1990	59	50408	718	121	597	16.85	85.44	12.17	1.42	0.24	0
1991	57	41826	262	131	131	50.00	73.38	4.60	0.63	0.31	0
1992	57	38957	709	209	500	29.48	68.35	12.44	1.82	0.54	0
1993	58	41096	934	225	709	24.09	70.86	16.10	2.27	0.55	0
1994	58	41284	2242	898	1344	40.05	71.18	38.66	5.43	2.18	0
1995	59	35334	2085	896	1189	42.97	59.89	35.34	5.90	2.54	0

KARNATAKA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

15. District : Mysore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2779	442382	1948	224	1724	11.50	15.92	0.70	0.44	0.05	0
1987	2883	519488	2879	313	2566	10.87	18.02	1.00	0.55	0.06	0
1988	2875	540641	2379	117	2262	4.92	18.80	0.83	0.44	0.02	0
1989	3007	512826	2294	274	2020	11.94	17.05	0.76	0.45	0.05	0
1990	3111	512859	2773	727	2046	26.22	16.49	0.89	0.54	0.14	0
1991	3115	505267	2559	1174	1385	45.88	16.22	0.82	0.51	0.23	0
1992	3115	552988	2913	663	2250	22.76	17.75	0.94	0.53	0.12	0
1993	3238	572526	7605	1846	5759	24.27	17.68	2.35	1.33	0.32	0
1994	3297	600966	10148	1772	8376	17.46	18.23	3.08	1.69	0.29	0
1995 (P)	3366	544691	14761	1773	12988	12.01	16.18	4.39	2.71	0.33	0

16. District : Mandya

1985											
1986	1499	330102	1391	98	1293	7.05	22.02	0.93	0.42	0.03	0
1987	1504	369131	2777	174	2603	6.27	24.54	1.85	0.75	0.05	0
1988	1503	379238	2258	31	2227	1.37	25.23	1.50	0.60	0.01	0
1989	1504	327128	1807	77	1730	4.26	21.75	1.20	0.55	0.02	0
1990	1580	349368	1172	91	1081	7.76	22.11	0.74	0.34	0.03	0
1991	1587	333809	1417	116	1301	8.19	21.03	0.89	0.42	0.03	0
1992	1653	423200	8105	1082	7023	13.35	25.60	4.90	1.92	0.26	0
1993	1653	327540	1353	38	1315	2.81	19.81	0.82	0.41	0.01	0
1994	1653	355068	4042	270	3772	6.68	21.48	2.45	1.14	0.08	0
1995(P)	1687	207592	11839	2545	9294	21.50	12.31	7.02	5.70	1.23	0

17. District : Chickmaglur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	944	175791	46	2	44	4.35	18.62	0.05	0.03	0.00	0
1987	967	193992	109	46	63	42.20	20.06	0.11	0.06	0.02	0
1988	1067	188163	1497	641	856	42.82	17.63	1.40	0.80	0.34	0
1989	918	204914	1296	244	1052	18.83	22.32	1.41	0.63	0.12	0
1990	945	204818	842	135	707	16.03	21.67	0.89	0.41	0.07	0
1991	979	205853	729	186	543	25.51	21.03	0.74	0.35	0.09	0
1992	989	210787	4806	1345	3461	27.99	21.31	4.86	2.28	0.64	0
1993	1011	326387	45124	14344	30780	31.79	32.28	44.63	13.83	4.39	0
1994	1085	319561	57231	8407	48824	14.69	29.45	52.75	17.91	2.63	0
1995(P)	1107	252462	37093	4768	32325	12.85	22.81	33.51	14.69	1.89	0

18. District : Hassan

1985											
1986	1399	286242	971	96	875	9.89	20.46	0.69	0.34	0.03	0
1987	1400	304193	453	22	431	4.86	21.73	0.32	0.15	0.01	0
1988	1400	322757	2683	1064	1619	39.66	23.05	1.92	0.83	0.33	0
1989	1440	347547	3173	776	2397	24.46	24.14	2.20	0.91	0.22	0
1990	1460	354933	3253	460	2793	14.14	24.31	2.22	0.91	0.13	0
1991	1489	388807	4002	397	3605	9.92	26.11	2.69	1.03	0.10	1
1992	1521	423200	8105	1082	7023	13.35	27.82	5.33	1.92	0.26	0
1993	1553	481694	33171	5390	27781	16.25	31.02	21.36	6.89	1.12	0
1994	1575	489527	66082	4988	61094	7.55	31.08	41.96	13.50	1.02	0
1995(P)	1608	539920	87284	8443	78841	9.67	33.58	54.28	16.17	1.56	0

KARNATAKA - Districtwise & Yearwise Epidemological Data & Parameters (1985 - 1995)

19. District : D. Kannda

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2395	243566	175	1	174	0.57	10.17	0.07	0.07	0.00	0
1987	2395	255390	105	0	105	0.00	10.66	0.04	0.04	0.00	0
1988	2469	265928	86	10	76	11.63	10.77	0.03	0.03	0.00	0
1989	2168	289606	279	2	277	0.72	13.36	0.13	0.10	0.00	0
1990	2568	276785	114	4	110	3.51	10.78	0.04	0.04	0.00	0
1991	2582	287171	340	6	334	1.76	11.12	0.13	0.12	0.00	0
1992	2638	298658	992	24	968	2.42	11.32	0.38	0.33	0.01	0
1993	2690	325512	4588	24	4564	0.52	12.10	1.71	1.41	0.01	0
1994	2707	315493	4744	21	4723	0.44	11.65	1.75	1.50	0.01	0
1995	2763	352824	9209	1675	7534	18.19	12.77	3.33	2.61	0.47	0

20. District : Kodagu

1985											
1986	474	84716	34	0	34	0.00	17.87	0.07	0.04	0.00	0
1987	474	96426	11	1	10	9.09	20.34	0.02	0.01	0.00	0
1988	532	95782	10	3	7	30.00	18.00	0.02	0.01	0.00	0
1989	652	106260	38	2	36	5.26	16.30	0.06	0.04	0.00	0
1990	543	92003	9	0	9	0.00	16.94	0.02	0.01	0.00	0
1991	540	96130	13	1	12	7.69	17.80	0.02	0.01	0.00	0
1992	485	97055	18	2	16	11.11	20.01	0.04	0.02	0.00	0
1993	485	95539	45	1	44	2.22	19.70	0.09	0.05	0.00	0
1994	578	96332	80	4	76	5.00	16.67	0.14	0.08	0.00	0
1995	590	86115	181	3	178	1.66	14.60	0.31	0.21	0.00	0

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

1. District : Trivandrum

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2747	117123	280	15	265	5.36	4.26	0.10	0.24	0.01	0
1987	2747	144314	357	14	343	3.92	5.25	0.13	0.25	0.01	0
1988	2804	162509	441	31	410	7.03	5.80	0.16	0.27	0.02	0
1989	2858	179270	498	48	450	9.64	6.27	0.17	0.28	0.03	0
1990	2911	187383	423	46	377	10.87	6.44	0.15	0.23	0.02	1
1991	2964	167221	528	72	456	13.64	5.64	0.18	0.32	0.04	0
1992	3023	124468	603	39	564	6.47	4.12	0.20	0.48	0.03	0
1993	2946	145476	773	49	724	6.34	4.94	0.26	0.53	0.03	0
1994	3062	141591	798	50	748	6.27	4.62	0.26	0.56	0.04	0
1995	3062	174438	2832	215	2617	7.59	5.70	0.92	1.62	0.12	2

2. District : Quilon

1985											
1986	2320	145112	435	12	423	2.76	6.25	0.19	0.30	0.01	0
1987	2320	168590	579	30	549	5.18	7.27	0.25	0.34	0.02	0
1988	2349	217725	719	30	689	4.17	9.27	0.31	0.33	0.01	1
1989	2394	205976	686	46	640	6.71	8.60	0.29	0.33	0.02	0
1990	2439	203987	636	32	604	5.03	8.36	0.26	0.31	0.02	0
1991	2483	199848	729	25	704	3.43	8.05	0.29	0.36	0.01	0
1992	2533	187882	980	40	940	4.08	7.42	0.39	0.52	0.02	0
1993	2407	186898	908	24	884	2.64	7.76	0.38	0.49	0.01	0
1994	2524	172397	841	30	811	3.57	6.83	0.33	0.49	0.02	0
1995	2524	173219	1120	58	1062	5.18	6.86	0.44	0.65	0.03	0

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

3. District : Alleppey

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1974	68644	367	8	359	2.18	3.48	0.19	0.53	0.01	0
1987	1974	101286	526	14	512	2.66	5.13	0.27	0.52	0.01	0
1988	1942	110733	709	27	682	3.81	5.70	0.37	0.64	0.02	0
1989	1979	139741	916	101	815	11.03	7.06	0.46	0.66	0.07	0
1990	2016	147073	1172	61	1111	5.20	7.30	0.58	0.80	0.04	0
1991	2052	101288	1062	78	984	7.34	4.94	0.52	1.05	0.08	0
1992	2093	90649	1278	65	1213	5.09	4.33	0.61	1.41	0.07	0
1993	2001	64773	1303	22	1281	1.69	3.24	0.65	2.01	0.03	0
1994	2044	57566	1391	62	1329	4.46	2.82	0.68	2.42	0.11	0
1995	2044	73211	1354	79	1275	5.83	3.58	0.66	1.85	0.11	0

4. District : Pathanamthitta

1985											
1986	1168	50489	306	5	301	1.63	4.32	0.26	0.61	0.01	0
1987	1168	78009	328	9	319	2.74	6.68	0.28	0.42	0.01	0
1988	1171	103164	490	6	484	1.22	8.81	0.42	0.47	0.01	0
1989	1194	106582	418	9	409	2.15	8.93	0.35	0.39	0.01	0
1990	1216	107437	478	5	473	1.05	8.84	0.39	0.44	0.00	0
1991	1238	99555	434	4	430	0.92	8.04	0.35	0.44	0.00	0
1992	1263	74695	502	7	495	1.39	5.91	0.40	0.67	0.01	0
1993	1188	61556	584	9	575	1.54	5.18	0.49	0.95	0.01	0
1994	1197	51799	673	15	658	2.23	4.33	0.56	1.30	0.03	0
1995	1177	45004	755	22	733	2.91	3.82	0.64	1.68	0.05	1

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

5. District : Kottayam

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1796	66276	152	2	150	1.32	3.69	0.08	0.23	0.00	0
1987	1796	96421	130	3	127	2.31	5.37	0.07	0.13	0.00	0
1988	1758	97939	205	6	199	2.93	5.57	0.12	0.21	0.01	0
1989	1792	104763	252	11	241	4.37	5.85	0.14	0.24	0.01	0
1990	1825	101343	242	9	233	3.72	5.55	0.13	0.24	0.01	0
1991	1858	98059	261	12	249	4.60	5.28	0.14	0.27	0.01	0
1992	1895	99811	334	10	324	2.99	5.27	0.18	0.33	0.01	0
1993	1828	93757	368	18	350	4.89	5.13	0.20	0.39	0.02	0
1994	1870	90363	396	18	378	4.55	4.83	0.21	0.44	0.02	1
1995	1870	86898	463	24	439	5.18	4.65	0.25	0.53	0.03	0

6. District : Idukki

1985											
1986	1028	17405	41	0	41	0.00	1.69	0.04	0.24	0.00	0
1987	1028	33868	31	0	31	0.00	3.29	0.03	0.09	0.00	0
1988	1117	43666	51	1	50	1.96	3.91	0.05	0.12	0.00	0
1989	1139	40044	48	0	48	0.00	3.52	0.04	0.12	0.00	0
1990	1160	54868	45	0	45	0.00	4.73	0.04	0.08	0.00	0
1991	1181	61970	41	4	37	9.76	5.25	0.03	0.07	0.01	0
1992	1205	49811	71	0	71	0.00	4.13	0.06	0.14	0.00	0
1993	1078	45041	146	0	146	0.00	4.18	0.14	0.32	0.00	0
1994	1118	46072	94	3	91	3.19	4.12	0.08	0.20	0.01	0
1995	1118	58925	150	13	137	8.67	5.27	0.13	0.25	0.02	0

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

7. District : Trichur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2582	66524	504	25	479	4.96	2.58	0.20	0.76	0.04	0
1987	2582	88282	488	22	463	4.51	3.42	0.19	0.55	0.02	0
1988	2536	120294	726	2	724	0.28	4.74	0.29	0.60	0.00	0
1989	2585	136067	1050	1	1049	0.10	5.26	0.41	0.77	0.00	0
1990	2633	140243	1066	9	1057	0.84	5.33	0.40	0.76	0.01	0
1991	2681	139782	1305	14	1291	1.07	5.21	0.49	0.93	0.01	0
1992	2775	135455	1541	17	1524	1.10	4.88	0.56	1.14	0.01	0
1993	2737	109033	1650	4	1646	0.24	3.98	0.60	1.51	0.00	0
1994	2834	69693	1306	12	1294	0.92	2.46	0.46	1.87	0.02	0
1995	2834	77561	1112	35	1077	3.15	2.74	0.39	1.43	0.05	0

8. District : Ernakulam

1985											
1986	2682	73851	195	5	190	2.56	2.75	0.07	0.26	0.01	0
1987	2682	131686	228	8	220	3.51	4.91	0.09	0.17	0.01	0
1988	2673	145455	419	6	413	1.43	5.44	0.16	0.29	0.00	0
1989	2725	154613	461	10	451	2.17	5.67	0.17	0.30	0.01	0
1990	2776	155585	508	12	496	2.36	5.60	0.18	0.33	0.01	0
1991	2826	151534	415	16	399	3.86	5.36	0.15	0.27	0.01	0
1992	2882	143826	580	20	560	3.45	4.99	0.20	0.40	0.01	0
1993	2817	146457	743	16	727	2.15	5.20	0.26	0.51	0.01	0
1994	2909	12392	787	30	757	3.81	0.43	0.27	6.35	0.24	0
1995	2909	126986	594	31	563	5.22	4.37	0.20	0.47	0.02	0

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

9. District : Palghat

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2183	34331	153	0	153	0.00	1.57	0.07	0.45	0.00	0
1987	2163	57254	78	1	77	1.28	2.65	0.04	0.14	0.00	0
1988	2295	76789	143	4	139	2.80	3.35	0.06	0.19	0.01	0
1989	2339	77902	220	8	212	3.64	3.33	0.09	0.28	0.01	0
1990	2383	92686	239	3	236	1.26	3.89	0.10	0.26	0.00	0
1991	2426	96623	244	2	242	0.82	3.98	0.10	0.25	0.00	0
1992	2474	94916	234	3	231	1.28	3.84	0.09	0.25	0.00	0
1993	2382	89184	241	0	241	0.00	3.74	0.10	0.27	0.00	0
1994	2504	70227	260	1	259	0.38	2.80	0.10	0.37	0.00	0
1995	2504	62936	224	6	218	2.68	2.51	0.09	0.36	0.01	0

10. District : Malapuram

1985											
1986	2542	65767	442	13	429	2.94	2.59	0.17	0.67	0.02	0
1987	2542	94283	486	10	476	2.06	3.71	0.19	0.52	0.01	0
1988	2790	115894	569	11	558	1.93	4.15	0.20	0.49	0.01	0
1989	2844	137079	646	22	624	3.41	4.82	0.23	0.47	0.02	0
1990	2897	138667	710	15	695	2.11	4.79	0.25	0.51	0.01	0
1991	2949	119284	780	34	746	4.36	4.04	0.26	0.65	0.03	0
1992	3008	91460	841	12	829	1.43	3.04	0.28	0.92	0.01	0
1993	3096	68181	770	12	758	1.56	2.20	0.25	1.13	0.02	0
1994	3342	45947	619	32	587	5.17	1.37	0.19	1.35	0.07	0
1995	3342	77924	741	45	696	6.07	2.33	0.22	0.95	0.06	0

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

11. District : Kozhikode

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2377	48842	292	0	292	0.00	2.05	0.12	0.60	0.00	0
1987	2377	61922	302	1	301	0.33	2.61	0.13	0.49	0.00	0
1988	2499	85199	370	3	367	0.81	3.41	0.15	0.43	0.00	0
1989	2547	124899	451	5	446	1.11	4.90	0.18	0.36	0.00	0
1990	2594	130312	418	9	409	2.15	5.02	0.16	0.32	0.01	0
1991	2641	117282	436	10	426	2.29	4.44	0.17	0.37	0.01	0
1992	2694	106179	527	4	523	0.76	3.94	0.20	0.50	0.00	0
1993	2619	91134	654	22	632	3.36	3.48	0.25	0.72	0.02	0
1994	2747	76244	499	15	484	3.01	2.78	0.18	0.65	0.02	0
1995	2747	100577	566	17	549	3.00	3.66	0.21	0.56	0.02	0

12. District : Cannanore

1985											
1986	2043	38812	190	2	188	1.05	1.90	0.09	0.49	0.01	0
1987	2043	57309	201	0	201	0.00	2.81	0.10	0.35	0.00	0
1988	2155	95242	246	3	243	1.22	4.42	0.11	0.26	0.00	0
1989	2197	113786	356	2	354	0.56	5.18	0.16	0.31	0.00	0
1990	2238	125856	360	7	353	1.94	5.62	0.16	0.29	0.01	0
1991	2279	117118	395	11	384	2.78	5.14	0.17	0.34	0.01	0
1992	2324	108275	513	5	508	0.97	4.66	0.22	0.47	0.00	0
1993	2251	89604	525	0	525	0.00	3.98	0.23	0.59	0.00	0
1994	2146	87732	705	1	704	0.14	4.09	0.33	0.80	0.00	0
1995	2146	108927	1110	98	1012	8.83	5.08	0.52	1.02	0.09	0

KERALA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

13. District : Kasaragod

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	924	2977	15	0	15	0.00	0.32	0.02	0.50	0.00	0
1987	924	3287	23	0	23	0.00	0.36	0.02	0.70	0.00	0
1988	975	20273	50	1	49	2.00	2.08	0.05	0.25	0.00	0
1989	994	39232	105	1	104	0.95	3.95	0.11	0.27	0.00	0
1990	1012	48328	97	0	97	0.00	4.78	0.10	0.20	0.00	0
1991	1030	41077	110	2	108	1.82	3.99	0.11	0.27	0.00	0
1992	1051	42125	233	2	231	0.86	4.01	0.22	0.55	0.00	0
1993	1071	32745	599	0	599	0.00	3.06	0.56	1.83	0.00	0
1994	1140	29839	673	2	671	0.30	2.62	0.59	2.26	0.01	0
1995	1140	44438	795	43	752	5.41	3.90	0.70	1.79	0.10	1

14. District : Wynad

1985											
1986	586	14103	10	0	10	0.00	2.41	0.02	0.07	0.00	0
1987	586	21562	15	0	15	0.00	3.68	0.03	0.07	0.00	0
1998	626	26844	9	1	8	11.11	4.29	0.01	0.03	0.00	0
1989	638	28053	19	0	19	0.00	4.40	0.03	0.07	0.00	0
1990	650	33874	17	1	16	5.88	5.21	0.03	0.05	0.00	0
1991	662	32691	18	1	17	5.56	4.94	0.03	0.06	0.00	0
1992	675	23945	18	0	18	0.00	3.55	0.03	0.08	0.00	0
1993	672	20582	13	0	13	0.00	3.06	0.02	0.06	0.00	0
1994	920	27900	33	1	32	3.03	3.03	0.04	0.12	0.00	0
1995	920	34311	62	0	62	0.00	3.73	0.07	0.18	0.00	0

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Indore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1591	162540	1448	390	1058	26.93	10.22	0.91	0.89	0.24	0
1987	1640	134435	3797	934	2863	24.60	8.20	2.32	2.82	0.69	0
1988	1671	157665	3525	873	2652	24.77	9.44	2.11	2.24	0.55	0
1989	1713	178664	1978	391	1587	19.77	10.43	1.15	1.11	0.22	0
1990	1756	209915	1215	220	995	18.11	11.95	0.69	0.58	0.10	0
1991	1831	226886	719	192	527	26.70	12.39	0.39	0.32	0.08	0
1992	1874	234105	706	111	595	15.72	12.49	0.38	0.30	0.05	0
1993	1923	234527	972	193	779	19.86	12.20	0.51	0.41	0.08	0
1994	1972	206011	1032	250	782	24.22	10.45	0.52	0.50	0.12	0
1995(P)	2013	196540	971	221	750	22.76	9.76	0.48	0.49	0.11	0

2. District : Dhar

1985											
1986	1194	158085	1443	439	1004	30.42	13.24	1.21	0.91	0.28	0
1987	1234	308498	26305	9272	17033	35.25	25.00	21.32	8.53	3.01	0
1988	1255	261983	16649	3530	13119	21.20	20.88	13.27	6.35	1.35	0
1989	1286	214268	14488	2318	12170	16.00	16.66	11.27	6.76	1.08	0
1990	1319	203703	11576	1260	10316	10.88	15.44	8.78	5.68	0.62	0
1991	1367	179625	5276	643	4633	12.19	13.14	3.86	2.94	0.36	0
1992	1401	202568	4502	517	3985	11.48	14.46	3.21	2.22	0.26	0
1993	1436	246881	8581	1863	6718	21.71	17.19	5.98	3.48	0.75	0
1994	1472	221045	6231	860	5371	13.80	15.02	4.23	2.82	0.39	0
1995(P)	1502	218935	6799	600	6199	8.82	14.58	4.53	3.11	0.27	0

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Jhabua

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	900	149468	8752	4973	3779	56.82	16.61	9.72	5.86	3.33	0
1987	923	214999	15871	8664	7207	54.59	23.29	17.20	7.38	4.03	0
1988	946	207190	12353	6589	5764	53.34	21.90	13.06	5.96	3.18	0
1989	970	184052	11491	5990	5501	52.13	18.97	11.85	6.24	3.25	0
1990	994	164303	12708	6386	6322	50.25	16.53	12.78	7.73	3.89	0
1991	1129	149828	10787	5681	5106	52.67	13.27	9.55	7.20	3.79	0
1992	1158	170455	9984	5452	4532	54.61	14.72	8.62	5.86	3.20	0
1993	1186	196680	10330	7142	3188	69.14	16.58	8.71	5.25	3.63	0
1994	1216	160038	8403	4771	3632	56.78	13.16	6.91	5.25	2.98	0
1995(P)	1241	185772	11554	7195	4359	62.27	14.97	9.31	6.22	3.87	0

4. District : Barwani

1985											
1986	1845	188084	5143	1696	3447	32.98	10.19	2.79	2.73	0.90	0
1987	1891	244590	19031	4475	14556	23.51	12.93	10.06	7.78	1.83	0
1988	1938	274343	14810	3256	11554	21.99	14.16	7.64	5.40	1.19	0
1989	1987	253179	11553	3009	8544	26.05	12.74	5.81	4.56	1.19	0
1990	2036	202905	6615	1769	4846	26.74	9.97	3.25	3.26	0.87	0
1991	2026	171977	4781	1216	3565	25.43	8.49	2.36	2.78	0.71	0
1992	2077	170876	3440	667	2773	19.39	8.23	1.66	2.01	0.39	0
1993	2129	185280	3596	607	2889	16.88	8.70	1.69	1.94	0.33	0
1994	2182	215044	6280	962	5318	15.32	9.86	2.88	2.92	0.45	0
1995											

5. District : Khandwa

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1306	170112	5613	2936	2677	52.31	13.03	4.30	3.30	1.73	0
1987	1339	180371	7417	2913	4504	39.27	13.47	5.54	4.11	1.62	0
1988	1373	204571	6103	2559	3544	41.93	14.90	4.45	2.98	1.25	0
1989	1407	199240	7089	3109	3980	43.86	14.16	5.04	3.56	1.56	0
1990	1442	199030	5176	2192	2984	42.35	13.80	3.59	2.60	1.10	0
1991	1433	193772	3115	1299	1816	41.70	13.52	2.17	1.61	0.67	0
1992	1469	217799	4010	1560	2450	38.90	14.83	2.73	1.84	0.72	0
1993	1505	224201	6844	1901	4943	27.78	14.90	4.55	3.05	0.85	0
1994	1543	236925	10820	3409	7411	31.51	15.35	7.01	4.57	1.44	0
1995	1575	215398	7427	2364	5063	31.83	13.68	4.72	3.45	1.10	0

6. District : Ujjain

1985											
1986	2162	218747	5868	2829	3039	48.21	10.12	2.71	2.68	1.29	0
1987	2216	296150	18054	9387	8667	51.99	13.36	8.15	6.10	3.17	0
1988	2271	349839	16779	7574	9205	45.14	15.40	7.39	4.80	2.16	0
1989	2328	278204	12056	3706	8250	30.74	11.95	5.18	4.33	1.33	0
1990	2381	242216	5821	2168	3653	37.24	10.17	2.44	2.40	0.90	0
1991	2419	225866	4647	1239	3408	26.66	9.34	1.92	2.06	0.55	0
1992	2480	233164	2600	784	1816	30.15	9.40	1.05	1.12	0.34	0
1993	2541	280571	3564	1461	2103	40.99	11.04	1.40	1.27	0.52	0
1994	2605	253553	4718	1977	2741	41.90	9.73	1.81	1.86	0.78	0
1995											

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Ratlam

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	886	134056	9811	6630	3181	67.58	15.13	11.07	7.32	4.95	0
1987	908	137125	7783	4325	3458	55.57	15.10	8.57	5.68	3.15	0
1988	931	158222	9607	6361	3246	66.21	16.99	10.32	6.07	4.02	0
1989	954	121758	3630	1944	1686	53.55	12.76	3.81	2.98	1.60	0
1990	978	115918	2447	1423	1024	58.15	11.85	2.50	2.11	1.23	0
1991	971	104936	1501	762	739	50.77	10.81	1.55	1.43	0.73	0
1992	996	121109	732	458	274	62.57	12.16	0.73	0.60	0.38	0
1993	1020	156706	1413	981	432	69.43	15.36	1.39	0.90	0.63	0
1994	1046	124110	2645	1611	1034	60.91	11.87	2.53	2.13	1.30	0
1995	1067	108187	2023	671	1352	33.17	10.14	1.90	1.87	0.62	0

8. District : Mandsaur

1985.											
1986	1428	180354	8600	4375	4225	50.87	12.63	6.02	4.77	2.43	0
1987	1464	202964	14570	4771	9799	32.75	13.86	9.95	7.18	2.35	0
1988	1500	265635	19869	9185	10684	46.23	17.71	13.25	7.48	3.46	0
1989	1538	185467	9436	2301	7135	24.39	12.06	6.14	5.09	1.24	0
1990	1576	180128	4715	1879	2836	39.85	11.43	2.99	2.62	1.04	0
1991	1555	173422	3429	1102	2327	32.14	11.15	2.21	1.98	0.64	0
1992	1594	181087	3237	1185	2052	36.61	11.36	2.03	1.79	0.65	0
1993	1634	213298	3697	1388	2309	37.54	13.05	2.26	1.73	0.65	0
1994	1675	234338	5275	2278	2997	43.18	13.99	3.15	2.25	0.97	0
1995(P)	1710	189081	3665	721	2944	19.67	11.06	2.14	1.94	0.38	0

9. District : Shajapur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	950	81968	2742	1276	1506	46.54	8.63	2.89	3.35	1.56	0
1987	974	137932	6582	2208	4374	33.55	14.16	6.76	4.77	1.60	0
1988	999	159484	9207	2939	6268	31.92	15.96	9.22	5.77	1.84	0
1989	1024	114336	5618	1344	4274	23.92	11.17	5.49	4.91	1.18	0
1990	1049	109122	4115	1215	2900	29.53	10.40	3.92	3.77	1.11	0
1991	1033	85773	2554	804	1750	31.48	8.30	2.47	2.98	0.94	0
1992	1058	89494	1917	448	1469	23.37	8.46	1.81	2.14	0.50	0
1993	1085	106300	2218	790	1428	35.62	9.80	2.04	2.09	0.74	0
1994	1112	106616	2950	879	2071	29.80	9.59	2.65	2.77	0.82	0
1995(P)	1135	82990	3133	700	2433	22.34	7.31	2.76	3.78	0.84	0

10 District : Bhopal

1985											
1986	1757	180750	12652	6055	6597	47.86	10.29	7.20	7.00	3.35	0
1987	1801	231880	27216	11241	15975	41.30	12.88	15.11	11.74	4.85	0
1988	1846	261170	30223	10919	19304	36.13	14.15	16.37	11.57	4.18	0
1989	1892	257451	26089	7838	18251	30.04	13.61	13.79	10.13	3.04	0
1990	1939	252115	22699	8492	14207	37.41	13.00	11.71	9.00	3.37	0
1991	2191	209278	13946	3823	10123	27.41	9.55	6.37	6.66	1.83	0
1992	2246	208624	9685	2420	7265	24.99	9.29	4.31	4.64	1.16	0
1993	2302	260298	12211	7746	4665	63.43	11.31	5.30	4.69	2.98	0
1994	2359	248135	16949	5740	11209	33.87	10.52	7.18	6.83	2.31	0
1995(P)	2408	253382	15388	2716	12672	17.65	10.52	6.39	6.07	1.07	0

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Raisen

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	802	81828	1372	330	1042	24.05	10.20	1.71	1.68	0.40	0
1987	822	106543	2629	708	1921	26.93	12.96	3.20	2.47	0.66	0
1988	843	122270	3599	758	2841	21.06	14.50	4.27	2.94	0.62	0
1989	864	117430	2563	723	1840	28.21	13.59	2.97	2.18	0.62	0
1990	885	112042	2473	837	1636	33.85	12.66	2.79	2.21	0.75	0
1991	877	98813	2444	54	1900	22.26	11.27	2.79	2.47	0.55	0
1992	899	97203	1891	368	1523	19.46	10.81	2.10	1.95	0.38	0
1993	922	114048	2796	421	2375	15.06	12.37	3.03	2.45	0.37	0
1994	945	103930	2859	552	2307	19.31	11.00	3.03	2.75	0.53	0
1995(P)	964	104691	3547	439	3108	12.38	10.86	3.68	3.39	0.42	0

12. District : Hoshangabad

1985											
1986	1135	104580	1432	528	904	36.87	9.21	1.26	1.37	0.50	0
1987	1163	125153	2026	586	1440	28.92	10.76	1.74	1.62	0.47	0
1988	1193	148742	2118	486	1632	22.95	12.47	1.78	1.42	0.33	0
1989	1222	150097	2064	450	1614	21.80	12.28	1.69	1.38	0.30	0
1990	1253	160916	2066	609	1457	29.48	12.84	1.65	1.28	0.38	0
1991	1266	145390	2036	345	1691	16.94	11.48	1.61	1.40	0.24	0
1992	1298	156115	1166	322	844	27.62	12.03	0.90	0.75	0.21	0
1993	1300	168033	2848	722	2126	25.35	12.93	2.19	1.69	0.43	0
1994	1363	17149	3439	844	2595	24.54	12.58	2.52	2.01	0.49	0
1995											

13. District : Vidisha

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	886	50856	1292	719	573	55.65	5.74	1.46	2.54	1.41	0
1987	908	89129	2195	1262	933	57.49	9.82	2.42	2.46	1.42	0
1988	931	105547	2048	797	1251	38.92	11.34	2.20	1.94	0.76	0
1989	954	102750	1589	499	1090	31.40	10.77	1.67	1.55	0.49	0
1990	978	104838	1481	481	1000	32.48	10.72	1.51	1.41	0.46	0
1991	971	94944	960	298	662	31.04	9.78	0.99	1.01	0.31	0
1992	995	110422	1205	309	896	25.64	11.10	1.21	1.09	0.28	0
1993	1020	114725	1214	454	760	37.40	11.25	1.19	1.06	0.40	0
1994	1046	98863	2267	862	1405	38.02	9.45	2.17	2.29	0.87	0
1995											

14. District : Rajgarh

1985											
1986	907	106981	8878	5567	3311	62.71	11.80	9.79	8.30	5.20	0
1987	930	176442	14919	8496	6423	56.95	18.97	16.04	8.46	4.82	0
1988	953	184477	16099	9169	6930	56.95	19.36	16.89	8.73	4.97	0
1989	977	143734	8427	3124	5303	37.07	14.71	8.63	5.86	2.17	0
1990	1001	137097	6540	3020	3520	46.18	13.70	6.53	4.77	2.20	0
1991	992	110506	3649	1489	2160	40.81	11.14	3.68	3.30	1.35	0
1992	1017	101984	2319	977	1342	42.13	10.03	2.28	2.27	0.96	0
1993	1042	142136	3932	2064	1868	52.49	13.64	3.77	2.77	1.45	0
1994	1069	141710	3589	1252	2337	34.88	13.26	3.36	2.53	0.88	0
1995											

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

15. District : Betul

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1046	88274	360	65	295	18.06	8.44	0.34	0.41	0.07	0
1987	1072	117169	1261	199	1062	15.78	10.93	1.18	1.08	0.17	0
1988	1099	153016	706	162	544	22.95	13.92	0.64	0.46	0.11	0
1989	1126	144160	781	141	640	18.05	12.80	0.69	0.54	0.10	0
1990	1154	151575	496	91	405	18.35	13.13	0.43	0.33	0.06	0
1991	1181	140865	749	281	668	37.52	11.93	0.63	0.53	0.20	0
1992	1210	140011	805	196	609	24.35	11.57	0.67	0.57	0.14	0
1993	1140	149044	626	213	413	34.03	13.07	0.55	0.42	0.14	0
1994	1271	150464	1503	614	889	40.85	11.84	1.18	1.00	0.41	0
1995(P)	1297	164358	1820	739	1081	40.60	12.69	1.40	1.11	0.45	0

16. District : Gwalior

1985											
1986	1610	134006	1593	306	1287	19.21	8.32	0.99	1.19	0.23	0
1987	1650	129414	564	75	489	13.30	7.84	0.34	0.44	0.06	0
1988	1691	174900	1259	227	1032	18.03	10.34	0.74	0.72	0.13	0
1989	1733	183866	575	76	499	13.22	10.61	0.33	0.31	0.04	0
1990	1777	169802	380	86	294	22.63	9.56	0.21	0.22	0.05	0
1991	1813	172471	320	101	219	31.56	9.51	0.18	0.19	0.06	0
1992	1858	159785	506	174	332	34.39	8.60	0.27	0.32	0.11	0
1993	1904	153183	859	272	587	31.66	8.05	0.45	0.56	0.18	0
1994	1962	154879	1320	230	1090	17.42	7.89	0.67	0.85	0.15	0
1995(P)	2003	178609	1895	554	1341	29.23	8.92	0.95	1.06	0.31	0

17. District : Bhind

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1097	80279	1953	165	1788	8.45	7.32	1.78	2.43	0.21	0
1987	1125	82234	355	32	323	9.01	7.31	0.32	0.43	0.04	0
1988	1153	123366	892	106	786	11.88	10.70	0.77	0.72	0.09	0
1989	1182	108572	1098	146	952	13.30	9.19	0.93	1.01	0.13	0
1990	1211	87898	522	96	426	18.39	7.26	0.43	0.59	0.11	0
1991	1215	88305	612	231	381	37.75	7.27	0.50	0.69	0.26	0
1992	1245	105033	989	293	696	29.63	8.44	0.79	0.94	0.28	0
1993	1276	90956	785	111	674	14.14	7.13	0.62	0.86	0.12	0
1994	1308	119846	1005	181	824	18.01	9.16	0.77	0.84	0.15	0
1995(P)	1335	129219	3867	1258	2609	32.53	9.68	2.90	2.99	0.97	0

18. District : Morena

1985											
1986	4472	100464	1921	486	1435	25.30	2.25	0.43	1.91	0.48	0
1987	1509	117080	1004	195	809	19.42	7.76	0.67	0.86	0.17	0
1988	1547	146447	1865	534	1331	28.63	9.47	1.21	1.27	0.36	0
1989	1585	131206	1570	340	1230	21.66	8.28	0.99	1.20	0.26	0
1990	1625	123862	988	426	562	43.12	7.62	0.61	0.80	0.34	0
1991	1708	120954	1137	490	647	43.10	7.08	0.67	0.94	0.41	0
1992	1750	137913	1609	660	949	41.02	7.88	0.92	1.17	0.48	0
1993	1794	117976	1180	407	773	34.49	6.58	0.66	1.00	0.34	0
1994	1834	114963	1710	618	1092	36.14	6.27	0.93	1.49	0.54	0
1995(P)	1831	149078	2550	777	1773	30.47	8.14	1.39	1.71	0.52	0

19. District : Shivpuri

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	979	100003	3550	1199	2351	33.77	10.21	3.63	3.55	1.20	0
1987	1004	113237	5255	1393	3862	26.51	11.28	5.23	4.64	1.23	0
1988	1029	136191	9404	1755	7649	18.66	13.24	9.14	6.91	1.29	0
1989	1055	128934	5759	967	4792	16.79	12.22	5.46	4.47	0.75	0
1990	1081	115898	4826	1006	3820	20.85	10.72	4.46	4.16	0.87	0
1991	1132	130067	5493	969	4524	17.64	11.49	4.85	4.22	0.75	0
1992	1160	121347	6122	1074	5048	17.54	10.46	5.28	5.05	0.89	0
1993	1189	117374	5568	685	4883	12.30	9.87	4.68	4.74	0.58	0
1994	1219	129708	7070	1645	5425	23.27	10.64	5.80	5.45	1.26	0
1995(P)	1244	137237	7313	1124	6189	15.37	11.03	5.88	5.33	0.82	0

20. District : Guna

1985											
1986	1128	104696	6122	2497	3625	40.79	9.28	5.43	5.85	2.39	0
1987	1156	147252	10706	3236	7470	30.23	12.74	9.26	7.27	2.20	0
1988	1185	150839	7229	2229	5000	30.83	12.73	6.10	4.79	1.48	0
1989	1215	127591	5269	946	4323	17.95	10.50	4.34	4.13	0.74	0
1990	1245	126420	4922	1534	3388	31.17	10.15	3.95	3.89	1.21	0
1991	1309	100807	4394	1001	3393	22.78	7.70	3.36	4.36	0.99	0
1992	1342	111478	4065	826	3239	20.32	8.31	3.03	3.65	0.74	0
1993	1376	125949	6350	1583	4767	24.93	9.15	4.61	5.04	1.26	0
1994	1410	158006	8469	2278	6191	26.90	11.21	6.01	5.36	1.44	0
1995	1439	183846	8958	1746	7212	19.49	12.78	6.23	4.87	0.95	0

21. District : Rewa

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1361	117592	2468	610	1858	24.72	8.64	1.81	2.10	0.52	0
1987	1395	121890	1665	548	1117	32.91	8.74	1.19	1.37	0.45	0
1988	1430	166299	2599	749	1850	28.82	11.63	1.82	1.56	0.45	0
1989	1466	130713	1761	531	1230	30.15	8.92	1.20	1.35	0.41	0
1990	1503	149093	2915	925	1990	31.73	9.92	1.94	1.96	0.62	0
1991	1550	171712	3091	928	2163	30.02	11.08	1.99	1.80	0.54	0
1992	1589	169385	3255	1000	2255	30.72	10.66	2.05	1.92	0.59	0
1993	1629	149911	3476	776	2700	22.32	9.20	2.13	2.32	0.52	0
1994	1669	170636	3744	1802	1942	48.13	10.22	2.24	2.19	1.06	0
1995(P)	1704	177120	4726	1791	2935	37.90	10.39	2.77	2.67	1.01	0

22. District : Sidhi

1985											
1986	1322	76733	297	68	229	22.90	5.80	0.22	0.39	0.09	0
1987	1355	68242	483	99	384	20.50	5.04	0.36	0.71	0.15	0
1988	1389	77425	694	245	449	35.30	5.57	0.50	0.90	0.32	0
1989	1423	82077	805	305	500	37.89	5.77	0.57	0.98	0.37	0
1990	1459	82884	688	94	594	13.66	5.68	0.47	0.83	0.11	0
1991	1372	90368	1097	248	849	22.61	6.59	0.80	1.21	0.27	0
1992	1406	106100	1162	416	746	35.80	7.55	0.83	1.10	0.39	0
1993	1441	105604	1167	224	943	19.19	7.33	0.81	1.11	0.21	0
1994	1477	129352	1941	572	1369	29.47	8.76	1.31	1.50	0.44	0
1995(P)	1508	142218	2022	374	1648	18.50	9.43	1.34	1.42	0.26	0

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

23. District : Shahdol

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1526	104182	1831	111	1720	6.06	6.83	1.20	1.76	0.11	0
1987	1558	105685	1226	173	1053	14.11	6.78	0.79	1.16	0.16	0
1988	1597	130638	1265	165	1100	13.04	8.18	0.79	0.97	0.13	0
1989	1637	140827	1400	314	1086	22.43	8.60	0.86	0.99	0.22	0
1990	1678	143587	1258	203	1055	16.14	8.56	0.75	0.88	0.14	0
1991	1743	140298	2016	705	1311	34.97	8.05	1.16	1.44	0.50	0
1992	1787	145389	3193	773	2420	24.21	8.14	1.79	2.20	0.53	0
1993	1831	149457	5111	1421	3690	27.80	8.16	2.79	3.42	0.95	0
1994	1877	151601	4302	931	3371	21.64	8.08	2.29	2.84	0.61	0
1995	1916	188462	7094	1646	5448	23.20	9.84	3.70	3.76	0.87	0

24. District : Satna

1985											
1986	1304	92982	2597	1130	1467	43.51	7.13	1.99	2.79	1.22	0
1987	1336	100729	3078	1140	1938	37.04	7.54	2.30	3.06	1.13	0
1988	1370	127603	5162	2131	3031	41.28	9.31	3.77	4.05	1.67	0
1989	1404	111963	4892	1564	3328	31.97	7.97	3.48	4.37	1.40	0
1990	1439	108922	3876	123	2663	3.17	7.57	2.69	3.56	0.11	0
1991	1463	131801	3191	596	2595	18.68	9.01	2.18	2.42	0.45	0
1992	1499	129265	2852	890	1962	31.21	8.62	1.90	2.21	0.69	0
1993	1536	117907	3624	1214	2410	33.50	7.68	2.36	3.07	1.03	0
1994	1575	113679	3261	1329	1932	40.75	7.22	2.07	2.87	1.17	0
1995(P)	1608	132346	4577	1915	2662	41.84	8.23	2.85	3.46	1.45	0

25. District : Nowgaon

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1836	194785	6945	1950	4995	28.08	10.61	3.78	3.57	1.00	0
1987	1881	196667	9931	2015	7916	20.29	10.46	5.28	5.05	1.02	0
1988	1928	227756	9594	2537	7057	26.44	11.81	4.98	4.21	1.11	0
1989	1977	258800	7594	1685	5909	22.19	13.09	3.84	2.93	0.65	0
1990	2026	237001	6716	2068	4648	30.79	11.70	3.31	2.83	0.87	0
1991	2099	204412	6871	2394	4477	34.84	9.74	3.27	3.36	1.17	0
1992	2152	202085	8741	2860	5881	32.72	9.39	4.06	4.33	1.42	0
1993	2203	248763	6839	1323	5516	19.34	11.29	3.10	2.75	0.53	0
1994	2261	179901	5025	1265	3760	25.17	7.96	2.22	2.79	0.70	0
1995(P)	2308	235068	6369	1088	5281	17.08	10.18	2.76	2.71	0.46	0

26. District : Panna

1985											
1986	611	39714	449	252	197	56.12	6.50	0.73	1.13	0.63	0
1987	626	65141	595	284	311	47.73	10.41	0.95	0.91	0.44	0
1988	642	53001	616	258	358	41.88	8.26	0.96	1.16	0.49	0
1989	658	81104	743	251	492	33.78	12.33	1.13	0.92	0.31	0
1990	674	80749	935	267	668	28.56	11.98	1.39	1.16	0.33	0
1991	685	67322	1488	601	887	40.39	9.83	2.17	2.21	0.89	0
1992	702	78814	1568	662	906	42.22	11.23	2.23	1.99	0.84	0
1993	719	73714	1151	518	633	45.00	10.25	1.60	1.56	0.70	0
1994	737	70843	1469	656	813	44.66	9.61	1.99	2.07	0.93	0
1995(P)	752	82892	1524	821	703	53.87	11.02	2.03	1.84	0.99	0

27. District : Jabalpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2481	142915	674	311	363	46.14	5.76	0.27	0.47	0.22	0
1987	2543	206241	8267	5496	2771	66.48	8.11	3.25	4.01	2.66	0
1988	2607	239372	10887	7059	3828	64.84	9.18	4.18	4.55	2.95	0
1989	2672	206043	4132	1978	2154	47.87	7.71	1.55	2.01	0.96	0
1990	2339	175528	2303	1144	1159	49.67	7.50	0.98	1.31	0.65	0
1991	2645	149694	1564	722	842	46.16	5.66	0.59	1.04	0.48	0
1992	2711	144434	1867	1002	865	53.67	5.33	0.69	1.29	0.69	0
1993	2779	157924	2545	1819	726	71.47	5.68	0.92	1.61	1.15	0
1994	2849	248230	2288	441	1847	19.27	8.71	0.80	0.92	0.15	0
1995(P)	2908	298065	4931	2053	2878	41.63	10.25	1.70	1.65	0.69	0

28. District : Chhindwara

1985											
1986	1395	201073	354	74	280	20.90	14.41	0.25	0.18	0.04	0
1987	1430	209835	612	82	530	13.40	14.67	0.43	0.29	0.04	0
1988	1465	222865	561	71	490	12.66	15.21	0.38	0.25	0.03	0
1989	1502	233091	754	237	517	31.43	15.52	0.50	0.32	0.10	0
1990	1539	201798	475	151	324	31.79	13.11	0.31	0.24	0.07	0
1991	1563	162944	432	142	290	32.87	10.43	0.28	0.27	0.09	0
1992	1602	176237	1405	703	702	50.04	11.00	0.88	0.80	0.40	0
1993	1643	179915	790	396	394	50.13	10.95	0.48	0.44	0.22	0
1994	1684	188890	633	333	300	52.61	11.22	0.38	0.34	0.17	0
1995(P)	1719	228076	1131	364	767	32.18	13.27	0.66	0.50	0.16	0

29. District : Seoni

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	916	110715	919	302	617	32.86	12.09	1.00	0.83	0.27	0
1987	939	124605	4546	2006	2540	44.13	13.27	4.84	3.65	1.61	0
1988	962	139927	5876	1325	4551	22.55	14.55	6.11	4.20	0.95	0
1989	986	136490	6853	1484	5369	21.65	13.84	6.95	5.02	1.09	0
1990	1011	131856	3149	641	2508	20.36	13.04	3.11	2.39	0.49	0
1991	1000	118315	2749	590	2159	21.46	11.83	2.75	2.32	0.50	0
1992	1025	168099	3834	1199	2635	31.27	16.40	3.74	2.28	0.71	0
1993	1050	140558	5029	1890	3139	37.58	13.39	4.79	3.58	1.34	0
1994	1077	149389	3561	1458	2103	40.94	13.87	3.31	2.38	0.83	0
1995											

30. District : Balaghat

1985											
1986	1298	141980	357	42	315	11.76	10.94	0.28	0.25	0.03	0
1987	1331	153928	2783	294	2489	10.56	11.56	2.09	1.81	0.19	0
1988	1364	176181	420	47	373	11.19	12.92	0.31	0.24	0.03	0
1989	1398	161087	506	26	480	5.14	11.52	0.36	0.31	0.02	0
1990	1433	172320	496	32	464	6.45	12.03	0.35	0.29	0.02	0
1991	1363	172320	4507	968	3539	21.48	12.64	3.31	2.62	0.56	0
1992	1397	170489	6302	1540	4762	24.44	12.20	4.51	3.70	0.90	0
1993	1432	169636	8667	1047	7620	12.08	11.85	6.05	5.11	0.62	0
1994	1467	174431	9991	1275	8716	12.76	11.89	6.81	5.73	0.73	0
1995											

31. District : Mandla

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1172	121892	2133	732	1401	34.32	10.40	1.82	1.75	0.60	0
1987	1201	157709	11017	5262	5755	47.76	13.13	9.17	6.99	3.34	0
1988	1232	178851	10082	3722	6360	36.92	14.52	8.18	5.64	2.08	0
1989	1262	179406	9807	3944	5863	40.22	14.22	7.77	5.47	2.20	0
1990	1294	162926	8676	2832	5844	32.64	12.59	6.70	5.33	1.74	0
1991	1291	212444	13200	7713	5487	58.43	16.46	10.22	6.21	3.63	0
1992	1324	256241	16107	7449	8658	46.25	19.35	12.17	6.29	2.91	0
1993	1357	247979	21137	8269	12868	39.12	18.27	15.58	8.52	3.33	0
1994	1391	180456	14369	4457	9912	31.02	12.97	10.33	7.96	2.41	0
1995(P)	1420	231082	25320	9995	15325	39.47	16.27	17.83	10.96	4.33	0

32. District : Narsinghpur

1985											
1986	733	64522	380	179	201	47.11	8.80	0.52	0.59	0.28	0
1987	753	86051	421	262	159	62.23	11.43	0.56	0.49	0.30	0
1988	772	98477	664	283	381	42.62	12.76	0.86	0.67	0.29	0
1989	792	99221	149	57	92	38.26	12.53	0.19	0.15	0.06	0
1990	811	101192	409	150	259	36.67	12.48	0.50	0.40	0.15	0
1991	785	100569	364	102	262	28.02	12.81	0.46	0.36	0.10	0
1992	804	95061	169	81	88	47.93	11.82	0.21	0.18	0.09	0
1993	824	81259	556	223	333	40.11	9.86	0.67	0.68	0.27	0
1994	845	86415	721	292	429	40.50	10.23	0.85	0.83	0.34	0
1995(P)	862	85535	651	128	523	19.66	9.92	0.76	0.76	0.15	0

33. District : Sagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1495	108316	2828	991	1837	35.04	7.25	1.89	2.61	0.91	0
1987	1532	122025	5532	2461	3071	44.49	7.97	3.61	4.53	2.02	0
1988	1570	165158	5588	2501	3087	44.76	10.52	3.56	3.38	1.51	0
1989	1610	147468	6850	1804	5046	26.34	9.16	4.25	4.65	1.22	0
1990	1650	136449	7579	2241	5338	29.57	8.27	4.59	5.55	1.64	0
1991	1646	105077	7011	1684	5327	24.02	6.38	4.26	6.67	1.60	0
1992	1687	86694	6755	1181	5574	17.48	5.14	4.00	7.79	1.36	0
1993	1729	136088	10796	1853	8943	17.16	7.87	6.24	7.93	1.36	0
1994	1758	182296	15109	3540	11569	23.43	10.37	8.59	8.29	1.92	0
1995											

34. District : Damoh

1985											
1986	816	61016	1089	359	730	32.97	7.48	1.33	1.78	0.59	0
1987	836	76184	6058	2867	3191	47.33	9.11	7.25	7.95	3.76	0
1988	857	78750	5025	1894	3131	37.69	9.19	5.86	6.38	2.41	0
1989	879	86518	4011	1236	2775	30.82	9.84	4.56	4.64	1.43	0
1990	900	85869	3905	1712	2193	43.84	9.54	4.34	4.55	1.99	0
1991	898	87494	2466	918	1548	37.23	9.74	2.75	2.82	1.05	0
1992	920	103604	2827	830	1997	29.36	11.26	3.07	2.73	0.80	0
1993	943	104334	2720	851	1869	31.29	11.06	2.88	2.61	0.82	0
1994	967	122208	3698	1075	2623	29.07	12.64	3.82	3.03	0.88	0
1995(P)	987	128058	2695	596	2099	22.12	12.97	2.73	2.10	0.47	0

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

35. District : Bilaspur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1615	114500	499	239	260	47.90	7.09	0.31	0.44	0.21	0
1987	1655	125572	512	337	175	65.82	7.59	0.31	0.41	0.27	0
1988	1697	143232	1694	884	810	52.18	8.44	1.00	1.18	0.62	0
1989	1739	155784	2662	1262	1400	47.41	8.96	1.53	1.71	0.81	0
1990	1873	154019	1908	1187	721	62.21	8.22	1.02	1.24	0.77	0
1991	1892	199932	4569	3844	725	84.13	10.57	2.41	2.29	1.92	0
1992	1939	207415	5287	4114	1173	77.81	10.70	2.73	2.55	1.98	0
1993	1988	206209	4181	3225	956	77.13	10.37	2.10	2.03	1.56	0
1994	2038	228860	6804	4456	2348	65.49	11.23	3.34	2.97	1.95	1
1995(P)	2080	219689	5060	2320	2740	45.85	10.56	2.43	2.30	1.06	0

36. District : Janjgir

1985											
1986	1725	122412	2404	1530	874	63.64	7.10	1.39	1.96	1.25	0
1987	1768	143805	3885	3005	880	77.35	8.13	2.20	2.70	2.09	0
1988	1813	162152	5282	4161	1121	78.78	8.94	2.91	3.26	2.57	0
1989	1858	178356	6674	5223	1451	78.26	9.60	3.59	3.74	2.93	0
1990	1904	169760	5292	4355	937	82.29	8.92	2.78	3.12	2.57	0
1991	1904	195934	12240	10613	1627	86.71	10.29	6.43	6.25	5.42	0
1992	1952	174814	9607	7714	1893	80.30	8.96	4.92	5.50	4.41	0
1993	2001	180476	7694	6284	1410	81.67	9.02	3.85	4.26	3.48	0
1994	2051	208837	5276	3482	1794	66.00	10.18	2.57	2.53	1.67	0
1995(P)	2094	211543	9151	5485	3666	59.94	10.10	4.37	4.33	2.59	0

37. District : Ambikapur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1845	127267	4035	3035	1000	75.22	6.90	2.19	3.17	2.38	0
1987	1891	137073	4026	2902	1124	72.08	7.25	2.13	2.94	2.12	0
1988	1939	170134	6724	5063	1661	75.30	8.77	3.47	3.95	2.98	0
1989	1987	155942	8518	7166	1352	84.13	7.85	4.29	5.46	4.60	0
1990	2037	167003	7453	6055	1398	81.24	8.20	3.66	4.46	3.63	0
1991	2081	196659	13896	11115	2781	79.99	9.45	6.68	7.07	5.65	0
1992	2135	236439	17335	13316	4019	76.82	11.07	8.12	7.33	5.63	0
1993	2188	247632	18934	14696	4238	77.62	11.32	8.65	7.65	5.93	0
1994	2243	257307	24128	19465	4663	80.67	11.47	10.76	9.38	7.56	0
1995											

38. District : Raigarh

1985											
1986	1632	118691	6341	4321	2020	68.14	7.27	3.89	5.34	3.64	0
1987	1637	154110	7888	5076	2812	64.35	9.41	4.82	5.12	3.29	0
1988	1714	151199	7985	5310	2675	66.50	8.82	4.66	5.28	3.51	3
1989	1757	147009	8228	5915	2313	71.89	8.37	4.68	5.60	4.02	0
1990	1801	155212	10700	7542	3158	70.49	8.62	5.94	6.89	4.86	1
1991	1801	254260	36163	26648	9515	73.69	14.11	20.07	14.22	10.48	1
1992	1801	247651	36199	26740	9459	73.87	13.75	20.09	14.62	10.80	0
1993	1812	206141	21494	16086	5408	74.84	11.38	11.86	10.43	7.80	0
1994	1857	242761	24774	18067	6707	72.93	13.07	13.34	10.21	7.44	0
1995(P)	1895	270018	37801	28687	9114	75.89	14.25	19.95	14.00	10.62	0

39. District : Raipur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1807	135234	1100	601	499	54.64	7.48	0.61	0.81	0.44	0
1987	1851	163001	913	297	616	32.53	8.81	0.49	0.56	0.18	0
1988	1897	194237	1389	315	1074	22.68	10.24	0.73	0.72	0.16	3
1989	1944	179280	1422	354	1068	24.89	9.22	0.73	0.79	0.20	0
1990	1993	146469	463	140	323	30.24	7.35	0.23	0.32	0.10	0
1991	2052	113082	483	202	281	41.82	5.51	0.24	0.43	0.18	0
1992	2103	137996	1504	714	790	47.47	6.56	0.72	1.09	0.52	0
1993	2156	146797	2117	397	1720	18.75	6.81	0.98	1.44	0.27	0
1994	2210	206413	3141	626	2515	19.93	9.34	1.42	1.52	0.30	0
1995(P)	2256	218001	8575	1809	6766	21.10	9.66	3.80	3.93	0.83	0

40. District : Mahasamund

1985											
1986	1677	128183	408	284	124	69.61	7.64	0.24	0.32	0.22	0
1987	1718	165282	927	559	368	96.76	9.62	0.53	0.56	0.34	0
1988	1761	200273	1753	866	887	49.40	11.37	1.00	0.88	0.43	0
1989	1806	200825	2018	1022	996	50.64	11.12	1.12	1.00	0.51	0
1990	1851	181002	1144	770	374	67.31	9.78	0.62	0.63	0.43	0
1991	1851	187830	3392	2095	1297	61.76	10.15	1.83	1.81	1.12	2
1992	1897	208071	6139	3720	2419	60.60	10.97	3.24	2.95	1.79	0
1993	1944	198528	5224	2931	2293	56.11	10.21	2.69	2.63	1.48	0
1994	1993	236398	7437	3269	4168	43.96	11.86	3.73	3.15	1.38	4
1995											

41. District : Durg

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2137	162458	168	86	82	51.19	7.60	0.08	0.10	0.05	0
1987	2191	202117	774	331	443	42.76	9.22	0.35	0.38	0.16	0
1988	2245	214841	1022	240	782	23.48	9.57	0.46	0.48	0.11	0
1989	2301	202332	1616	107	1509	6.62	8.79	0.70	0.80	0.05	0
1990	2359	171535	781	44	737	5.63	7.27	0.33	0.46	0.03	0
1991	2398	159331	1076	384	692	35.69	6.64	0.45	0.68	0.24	0
1992	2459	197683	2897	1138	1759	39.28	8.04	1.18	1.47	0.58	0
1993	2520	195652	4306	1161	3145	26.96	7.76	1.71	2.20	0.59	0
1994	2583	286206	13217	3577	9640	27.06	11.08	5.12	4.62	1.25	18
1995(P)											

42. District : Rajnadgaon

1985											
1986	1320	151786	790	174	616	22.03	11.50	0.60	0.52	0.11	0
1987	1353	146926	1588	432	1156	27.20	10.86	1.17	1.08	0.29	0
1988	1386	147157	883	246	637	27.86	10.62	0.64	0.60	0.17	0
1989	1421	153593	1076	261	815	24.26	10.81	0.76	0.70	0.17	0
1990	1457	154616	1040	222	818	21.35	10.61	0.71	0.67	0.14	0
1991	1457	140560	4597	1427	3170	31.04	9.65	3.16	3.27	1.02	1
1992	1476	143229	5089	1485	3604	29.18	9.70	3.45	3.55	1.04	0
1993	1512	142825	7651	1354	6297	17.70	9.45	5.06	5.36	0.95	0
1994	1550	184255	15578	2171	13407	13.94	11.89	10.05	8.45	1.16	3
1995											

MADHYA PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

43. District : Jagdalpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1136	168481	19913	15625	4288	78.47	14.83	17.53	11.82	9.27	0
1987	1165	178904	20093	16603	3490	82.63	15.36	17.25	11.23	9.28	0
1988	1194	197250	17797	13815	3982	77.63	16.52	14.91	9.02	7.00	0
1989	1224	209874	17887	13494	4393	75.44	17.15	14.61	8.52	6.43	19
1990	1254	223402	27281	20307	6974	74.44	17.82	21.76	12.21	9.09	3
1991	1255	324135	31380	22591	8789	71.99	25.83	25.00	9.68	6.97	10
1992	1286	286539	23102	18077	5025	78.25	22.28	17.96	8.06	6.31	0
1993	1318	290126	18531	15070	3461	81.32	22.01	14.06	6.39	5.19	0
1994	1351	225234	17004	13550	3454	79.69	16.67	12.59	7.55	6.01	1
1995											

44. District : Kanker

1985											
1986	946	159437	16028	14221	1807	88.73	16.85	16.94	10.05	8.92	0
1987	969	198022	18673	16022	2651	85.80	20.44	19.27	9.43	8.09	0
1988	994	211895	18976	16025	2951	84.45	21.32	19.09	8.96	7.56	1
1989	1018	202333	19405	15627	3778	80.53	19.88	19.06	9.59	7.72	4
1990	1044	160416	23279	19992	3287	85.88	15.37	22.30	14.51	12.46	10
1991	1016	300767	52089	45861	6228	88.04	29.60	51.27	17.32	15.25	11
1992	1042	255531	41244	37094	4150	89.94	24.52	39.58	16.14	14.52	0
1993	1067	247340	40276	36065	4211	89.54	23.18	37.75	16.28	14.58	0
1994	1094	242784	37623	32135	5488	85.41	22.19	34.39	15.50	13.24	1
1995											

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

1. District : Aurangabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1783	243370	904	181	723	20.02	13.65	0.51	0.37	0.07	0
1987	1823	283623	1080	350	730	32.41	15.56	0.59	0.38	0.12	0
1988	1823	300468	2039	768	271	37.67	16.49	1.12	0.68	0.26	0
1989	1866	315964	4481	1328	3153	29.64	16.93	2.40	1.42	0.42	1
1990	1888	325260	3650	1128	2522	30.90	17.23	1.93	1.12	0.35	0
1991	1888	303030	5238	1835	3403	35.03	16.05	2.68	1.73	0.61	0
1992	2326	302815	6570	1283	5287	19.53	13.02	2.82	2.17	0.42	0
1993	2345	305035	7562	1568	5994	20.74	13.01	3.22	2.48	0.51	0
1994	2399	305320	5285	782	4503	14.80	12.73	2.20	1.73	0.26	0
1995	2421	334951	3937	0	3987	0.00	13.84	1.65	1.19	0.00	0

2. District : Beed

1985											
1986	1588	220156	3707	597	3110	16.10	13.86	2.33	1.68	0.27	0
1987	1588	208200	1463	174	1289	11.89	13.11	0.92	0.70	0.08	0
1988	1588	214509	1416	278	1128	19.63	13.51	0.89	0.66	0.13	0
1989	1588	221566	2423	701	1722	28.93	13.95	1.53	1.09	0.32	1
1990	1588	236729	2458	963	1495	39.18	14.91	1.55	1.04	0.41	0
1991	1608	225034	4657	1912	2745	41.06	13.99	2.90	2.07	0.85	0
1992	1888	254916	5717	1221	4496	21.36	13.50	3.03	2.24	0.48	0
1993	1929	279245	5940	886	5054	14.92	14.48	3.08	2.13	0.32	0
1994	1973	365017	7613	1485	6128	19.51	18.50	3.86	2.09	0.41	0
1995(P)	1993	268679	3734	0	3134	0.00	13.48	1.87	1.39	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

3. District : Jalna

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1159	142222	434	121	313	27.88	12.27	0.37	0.31	0.09	0
1987	1185	184436	775	279	496	36.00	15.56	0.65	0.42	0.15	0
1988	1216	191869	1518	557	961	36.69	15.78	1.25	0.79	0.29	0
1989	1216	240063	1727	481	1246	27.85	19.74	1.49	0.72	0.20	0
1990	1216	249544	1359	404	995	29.73	21.27	1.16	0.54	0.16	0
1991	1270	242017	1901	626	1275	32.93	19.06	1.50	0.79	0.26	0
1992	1421	259286	3931	875	3056	22.26	18.25	2.77	1.52	0.34	0
1993	1444	240020	4148	913	3235	22.01	16.62	2.87	1.73	0.38	0
1994	1478	249090	2863	637	2226	22.25	16.85	1.94	1.15	0.26	0
1995(P)	1492	242066	1305	0	1305	0.00	16.22	0.87	0.54	0.00	0

4. District : Nanded

1985											
1986	1980	277797	1836	73	1763	3.98	14.03	0.93	0.66		
1987	2024	310231	1024	43	981	4.20	15.33	0.51	0.33	0.01	0
1988	2024	307115	1171	82	1089	7.00	15.17	0.58	0.38	0.03	0
1989	2052	333567	1735	147	1588	8.47	16.26	0.85	0.52	0.04	0
1990	2077	314249	1787	255	1532	14.27	15.13	0.86	0.57	0.08	0
1991	2164	289772	1598	317	1281	19.84	13.39	0.74	0.55	0.11	0
1992	2426	372989	2371	450	1921	18.98	15.37	0.98	0.64	0.12	0
1993	2463	386163	4230	1215	3015	28.72	15.68	1.72	1.10	0.31	0
1994	2519	386292	6809	1898	4911	27.87	15.34	2.70	1.76	0.49	0
1995(P)	2549	380054	4703	0	4703	0.00	14.91	1.85	1.24	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

5. District : Latur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1414	176983	486	28	458	5.76	12.52	0.34	0.27	0.02	0
1987	1446	193297	226	20	206	8.85	13.37	0.16	0.12	0.01	0
1988	1470	199474	887	104	783	11.72	13.57	0.60	0.44	0.05	0
1989	1470	203248	1209	143	1066	11.83	13.03	0.86	0.59	0.07	0
1990	1470	242278	1451	330	1121	22.74	17.418	1.02	0.60	0.14	0
1991	1500	229587	1513	293	1220	19.37	15.31	1.01	0.66	0.13	0
1992	1738	256268	2285	461	1824	20.18	14.74	1.31	0.89	0.18	0
1993	1770	285733	3705	718	2987	19.38	16.14	2.09	1.30	0.25	0
1994	1810	257800	3139	431	2708	13.73	14.24	1.73	1.22	0.17	0
1995(P)	1834	229132	1603	0	1603	0.00	12.49	0.87	0.70	0.00	

6. District : Osmanabad

1985											
1986	1125	132929	532	60	472	11.28	11.82	0.47	0.40	0.05	0
1987	1150	142471	338	125	213	36.98	12.39	0.29	0.24	0.09	0
1988	1169	152158	840	149	691	17.74	13.02	0.72	0.55	0.10	0
1989	1189	148449	832	104	728	12.50	12.49	0.70	0.56	0.07	0
1990	1208	150976	825	182	643	22.06	12.50	0.68	0.55	0.12	0
1991	1208	144480	998	156	842	15.63	11.96	0.83	0.69	0.11	0
1992	1312	161483	2154	236	1918	10.96	12.31	1.64	1.33	0.15	0
1993	1353	172029	2697	364	2333	13.50	12.71	1.99	1.57	0.21	0
1994	1384	170725	1782	255	1527	14.31	12.34	1.29	1.04	0.15	0
1995(P)	1396	170117	807	0	807	0.00	12.19	0.58	0.47	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

7. District: Parbhani

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1869	219550	816	72	744	8.82	11.75	0.44	0.37	0.03	0
1987	1869	233164	628	117	511	18.63	12.48	0.34	0.27	0.05	0
1988	1902	237097	1755	340	1415	19.37	12.47	0.92	0.74	0.14	0
1989	1950	237387	2591	136	2455	5.25	12.17	1.33	1.09	0.06	0
1990	1973	284776	2626	230	2396	8.76	14.43	1.33	0.92	0.08	0
1991	1973	259030	1823	354	1469	19.42	13.13	0.92	0.70	0.14	0
1992	2195	288526	2159	420	1739	19.45	13.14	0.98	0.75	0.15	0
1993	2246	294266	2344	323	2021	13.78	13.10	1.04	0.80	0.11	0
1994	2297	303149	1710	276	1434	16.14	13.20	0.74	0.56	0.09	0
1995(P)	2315	304988	881	0	881	0.00	13.17	0.38	0.29	0.00	0

8. District: Amravati

1985											
1986	2064	275189	653	103	550	15.77	13.33	0.32	0.24	0.38	0
1987	2065	344153	1150	231	919	20.09	16.67	0.56	0.33	0.07	0
1988	2085	318388	2040	598	1442	29.31	15.27	0.98	0.64	0.19	0
1989	2139	312244	4591	754	3837	16.42	14.60	2.15	1.47	0.24	1
1990	2163	354458	3155	673	2482	21.33	16.39	1.46	0.89	0.19	0
1991	2220	287919	2266	481	1785	21.23	12.97	1.02	0.79	0.17	0
1992	2263	348191	5280	1208	4072	22.88	15.39	2.33	1.52	0.35	0
1993	2337	368685	8932	2221	6711	24.87	15.78	3.82	2.42	0.60	0
1994	2391	358397	10083	2815	7268	27.92	14.99	4.22	2.81	0.79	0
1995(P)	2406	397331	8404	0	8404	0.00	16.51	3.49	2.12	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

9. District : Akola

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2035	281870	759	112	647	14.76	13.85	0.37	0.27	0.04	0
1987	2050	355590	1067	222	845	20.81	17.35	0.52	0.30	0.06	0
1988	2068	356663	2623	549	2074	20.93	17.25	1.27	0.74	0.15	0
1989	2068	390319	5263	836	4427	15.88	18.87	2.54	1.35	0.21	0
1990	2133	443477	3983	962	3021	24.15	20.79	1.87	0.90	0.22	0
1991	2196	341799	2423	437	1986	18.04	15.56	1.10	0.71	0.13	0
1992	2273	412963	4817	895	3922	18.58	18.17	2.12	1.17	0.22	0
1993	2346	376145	6275	1089	5186	17.35	16.03	2.67	1.67	0.29	0
1994	2400	375238	7168	1488	5680	20.76	15.63	2.99	1.91	0.40	0
1995(P)	2425	387759	6523	0	6523	0.00	15.99	2.69	1.68	0.00	0

10. District : Buldhana

1985											
1986	1664	236543	1210	311	899	25.70	14.22	0.73	0.51	0.13	0
1987	1670	257418	2073	658	1415	31.74	15.41	1.24	0.66	0.26	0
1988	1691	285943	3636	1108	2528	30.47	15.33	0.51	0.33	0.01	0
1989	1722	256334	5352	1246	4106	23.28	14.89	3.11	2.09	0.49	0
1990	1742	286058	4376	902	3474	20.61	16.42	2.51	1.53	0.32	0
1991	1778	255254	3763	829	2934	22.03	14.36	2.12	1.47	0.32	0
1992	1943	312064	4808	1037	3771	21.57	16.06	2.47	1.54	0.33	0
1993	1995	323666	7968	1488	6480	18.67	16.22	3.99	2.46	0.46	0
1994	2041	324038	7055	1603	5452	22.72	15.88	3.46	2.18	0.49	0
1995(P)	2063	338329	5569	0	5569	0.00	16.40	2.70	1.65	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

11. District : Yeotmal

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1939	305292	3456	236	3220	6.83	15.74	1.78	1.13	0.08	0
1987	1959	341852	2527	288	2239	11.40	17.45	1.29	0.74	0.08	0
1988	1970	289877	4858	808	4050	16.63	14.71	2.47	1.68	0.28	0
1989	2001	296959	11901	1424	10477	11.97	14.84	5.95	4.01	0.48	0
1990	2033	338076	11395	1908	9487	16.74	16.63	5.61	3.37	0.56	0
1991	2094	285355	9925	1931	7994	19.46	13.63	4.74	3.48	0.68	0
1992	2127	335075	16441	2720	13721	16.54	15.75	7.73	4.91	0.81	0
1993	2196	327761	22211	3889	18322	17.51	14.93	10.11	6.78	1.19	0
1994	2246	397199	27528	6919	20609	25.13	17.68	12.26	6.93	1.74	0
1995(P)	2272	467636	31856	0	31856	0.00	20.58	14.02	6.81	0.00	0

12. District : Bhandara

1985											
1986	2011	285489	1315	211	1104	16.05	14.20	0.65	0.46	0.07	
1987	2017	345203	1847	553	1294	29.94	17.11	0.92	0.54	0.16	
1988	2023	310068	1212	277	935	22.85	15.33	0.60	0.39	0.09	0
1989	2058	314611	1136	301	835	26.50	15.29	0.55	0.36	0.10	0
1990	2082	312467	1046	330	716	31.55	15.01	0.50	0.33	0.11	0
1991	2093	272448	1077	372	705	34.54	13.02	0.51	0.40	0.14	0
1992	4144	328624	2434	561	1873	23.05	7.93	0.59	0.74	0.17	0
1993	2229	401115	6927	812	6115	11.72	18.00	3.11	1.73	0.20	0
1994	2280	502062	8874	1006	7868	11.34	22.02	3.89	1.77	0.20	0
1995(P)	2305	542525	10316	0	10316	0.00	23.54	4.48	1.90	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

13. District : Chandrapur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1527	205219	1578	473	1105	29.97	13.44	1.03	0.77	0.23	0
1987	1585	224273	2865	807	2058	28.17	14.15	1.81	1.28	0.36	0
1988	1636	240102	3241	493	2748	15.21	14.68	1.98	1.35	0.21	0
1989	1681	282974	1967	692	1275	35.18	16.83	1.17	0.70	0.24	1
1990	1696	303916	5975	2595	3380	43.43	17.92	3.52	1.97	0.85	4
1991	1781	314933	8154	4430	3724	54.33	17.68	4.58	2.59	1.41	4
1992	1827	308854	8641	2509	6132	54.06	16.90	4.73	2.80	0.81	0
1993	1879	330236	12980	2616	10364	20.15	17.58	6.91	3.93	0.79	0
1994	1921	415018	26268	5945	20323	22.63	21.60	13.67	6.33	1.43	1
1995(P)	1938	487200	31117	0	31117	0.00	23.12	16.06	6.94	0.00	0

14. District : Gadchiroli

1985											
1986	722	158468	7383	6439	944	87.21	21.95	10.23	4.66	4.06	0
1987	738	169909	7998	6199	1799	77.51	23.02	10.84	4.71	3.65	0
1988	750	166417	9072	6977	2095	76.91	2[illegible].19	12.10	5.45	4.19	5
1989	765	215402	13044	10240	2804	78.50	28.16	17.05	6.06	4.75	3
1990	774	211059	13577	10920	2657	80.43	27.27	17.54	6.43	5.17	2
1991	767	232191	20490	16702	3788	81.51	30.27	26.71	8.82	7.19	2
1992	810	236523	16511	12832	3679	77.72	29.20	20.38	6.98	5.43	0
1993	835	273174	15302	11054	4248	72.24	32.72	18.33	5.60	4.05	0
1994	844	325644	15746	8302	7444	52.72	38.58	18.66	4.84	2.55	0
1995(P)	861	424709	23206	0	23206	0.00	49.33	26.95	5.46	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

15. District : Nagpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3030	360691	2342	123	2219	5.25	11.90	0.77	0.65	0.03	0
1987	3054	404099	2202	176	2026	7.99	13.23	0.72	0.54	0.04	0
1988	3068	411590	3084	637	2447	20.65	13.42	1.01	0.75	0.15	0
1989	3140	408046	2901	636	2265	21.92	13.00	0.92	0.71	0.16	0
1990	3161	313299	3059	568	2491	18.57	9.91	0.97	0.98	0.18	0
1991	3395	412857	2594	422	2172	16.27	12.16	0.76	0.63	0.10	0
1992	3338	447551	6362	1062	5290	16.69	13.41	1.91	1.42	0.24	0
1993	1753	277006	8736	1026	7710	11.74	15.80	4.98	3.15	0.37	0
1994	1793	324797	16464	2925	13539	17.77	18.11	9.18	5.07	0.90	0
1995(P)	1818	327970	21006	0	21006	0.00	18.04	11.55	6.40	0.00	0

16. District : Wardha

1985											
1986	1023	158310	334	20	314	5.99	15.48	0.33	0.21	0.01	0
1987	1041	185903	274	29	245	10.58	17.86	0.26	0.15	0.02	0
1988	1060	178483	908	213	695	23.46	14.03	0.93	0.66	0.12	0
1989	1068	189452	942	124	818	13.16	15.33	0.51	0.33	0.01	0
1990	1080	187978	1003	244	759	24.33	17.41	0.93	0.53	0.13	0
1991	1087	173932	424	49	375	11.56	16.00	0.39	0.24	0.03	0
1992	1087	178316	1860	248	1612	13.33	16.40	1.71	1.04	0.14	0
1993	1127	201443	3217	534	2683	16.60	17.87	2.85	1.60	0.27	0
1994	1127	209981	6501	1076	5425	16.55	18.63	5.77	3.10	0.51	0
1995(P)	1168	198968	10261	0	10261	0.00	17.03	8.79	5.16	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

17. District : Dhule

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2302	293860	1865	862	1003	46.22	12.77	0.81	0.63	0.29	0
1987	2353	354106	8449	3665	4784	43.38	15.05	3.59	2.39	1.04	0
1988	2414	275268	8742	2937	5805	33.60	11.40	3.62	3.18	1.07	0
1989	2447	361818	11090	4214	6876	38.00	14.79	4.53	3.07	1.16	0
1990	2475	350409	6364	2415	3949	37.95	14.16	2.57	1.82	0.69	0
1991	2500	331155	4430	2270	2160	51.24	13.25	1.77	1.34	0.69	0
1992	2608	377115	6038	2734	3304	45.28	14.46	2.32	1.60	0.72	0
1993	2680	334226	6569	2503	4066	38.10	12.47	2.45	1.97	0.75	0
1994	2741	435128	11043	5473	5570	49.56	15.87	4.03	2.54	1.26	8
1995(P)	2773	441364	10028	0	10028	0.00	15.92	3.62	2.27	0.00	0

18. District : Jalgaon

1985											
1986	2939	376929	1454	693	761	47.66	12.83	0.49	0.39	0.18	0
1987	3005	475874	6774	3970	2774	58.61	15.84	2.25	1.42	0.83	0
1988	3083	565958	9913	3712	6201	37.45	18.36	3.22	1.75	0.66	0
1989	3124	550273	11983	4905	7078	40.93	17.61	3.84	2.18	0.89	0
1990	3161	504151	5326	1639	3687	30.77	15.95	1.68	1.06	0.33	0
1991	3191	509820	3980	1617	2363	40.63	15.98	1.25	0.78	0.32	0
1992	3276	561463	6286	2237	4049	35.59	17.14	1.92	1.12	0.40	0
1993	3373	527047	16045	5778	10267	36.01	15.63	4.76	3.04	1.10	0
1994	3450	515316	17570	7816	9754	44.48	14.94	5.09	3.41	1.52	0
1995(P)	3486	532263	18690	0	18690	0.00	15.27	5.36	3.51	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

19. District : Raigad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1625	177906	643	144	499	22.40	10.95	0.40	0.36	0.08	0
1987	1662	199198	775	391	384	50.45	11.99	0.47	0.39	0.20	0
1988	1716	201817	789	295	494	37.39	11.76	0.46	0.39	0.15	0
1989	1759	215418	2395	599	1796	25.01	12.25	1.36	1.11	0.28	0
1990	1780	199480	3015	567	2448	18.81	11.21	1.69	1.51	0.28	0
1991	1723	201926	10203	2954	7249	28.95	11.72	5.92	5.05	1.46	4
1992	1868	224282	19090	4351	14739	22.79	12.01	10.22	8.51	1.94	0
1993	1920	231343	9638	3034	6604	31.48	12.05	5.02	4.17	1.31	0
1994	1973	233773	7518	3013	4505	40.08	11.85	3.81	3.22	1.29	0
1995(P)	1996	288292	15565	0	15565	0.00	14.44	7.80	5.40	0.00	0

20. District : Nasik

1985											
1986	3403	407865	436	115	321	26.38	11.99	0.13	0.11	0.03	0
1987	3433	457781	3505	1665	1840	47.50	13.33	1.02	0.77	0.36	0
1988	3453	419116	3489	1464	2025	41.96	12.14	1.01	0.83	0.35	0
1989	3528	435971	7240	2760	4480	38.12	12.36	2.05	1.66	0.63	0
1990	3569	408518	3972	1532	2440	38.57	11.45	1.11	0.97	0.38	0
1991	3733	408008	5292	2156	3136	40.74	10.93	1.42	1.30	0.53	0
1992	3989	447063	8114	3660	4454	45.11	11.21	2.03	1.81	0.82	0
1993	4075	418013	14358	4927	9431	34.32	10.26	3.52	3.43	1.18	0
1994	4167	524573	14920	5544	9376	37.16	12.59	3.58	2.84	1.06	0
1995P)	4213	693538	42131	0	42131	0.00	16.46	10.00	6.07	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

21.District : Thane

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	4151	445036	854	453	401	53.04	10.72	0.21	0.19	0.10	0
1987	4160	532135	2327	1552	775	66.70	12.79	0.56	0.44	0.29	0
1988	4180	495181	4449	2026	2423	45.54	11.85	1.06	0.90	0.41	0
1989	4262	459029	7384	1725	5659	23.36	10.77	1.73	1.61	0.38	0
1990	4313	516475	14338	3343	10995	23.32	11.97	3.32	2.78	0.65	0
1991	4754	553415	21146	5811	15335	27.48	11.64	4.45	3.82	1.05	0
1992	5440	530648	34553	12655	21898	36.62	9.75	6.35	6.51	2.38	0
1993	5451	513055	36928	14613	22315	39.57	9.41	6.77	7.20	2.85	0
1994	5669	660311	30467	12956	17511	42.52	11.65	5.37	4.61	1.96	0
1995(P)	5714	905474	56404	0	56404	0.00	15.77	9.82	6.23	0.00	0

22.District: Ratnagiri

1985											
1986	1423	206260	452	92	360	20.35	14.49	0.32	0.22	0.04	0
1987	1435	237383	380	118	262	31.05	16.54	0.26	0.16	0.05	0
1988	1435	239469	488	63	425	12.91	16.69	0.34	0.20	0.03	0
1989	1435	243803	570	74	496	12.98	14.03	0.93	0.66	0.03	0
1990	1440	238439	514	64	450	12.45	15.33	0.51	0.33	0.01	0
1991	1400	220604	715	136	579	19.02	15.32	0.50	0.32	0.06	0
1992	1563	228250	1726	265	1461	15.35	14.60	1.10	0.76	0.12	0
1993	1636	244335	1919	381	1538	19.85	14.93	1.17	0.79	0.16	0
1994	1636	227072	2588	464	2124	17.93	13.88	1.58	1.14	0.20	0
1995(P)	1689	261517	3272	0	3272	0.00	15.48	1.94	1.25	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

23. District: Sindhudurg

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	797	127229	307	30	277	9.77	15.96	0.39	0.24	0.02	0
1987	814	134498	133	19	114	14.29	16.52	0.16	0.10	0.01	0
1988	811	128429	116	23	93	19.83	16.70	0.16	0.09	0.02	0
1989	811	135440	126	24	102	19.05	16.70	0.16	0.09	0.02	0
1990	867	147996	75	19	56	25.33	17.07	0.09	0.05	0.01	0
1991	867	130401	102	32	70	31.37	15.04	0.12	0.08	0.02	0
1992	867	129099	204	43	161	21.08	14.89	0.24	0.16	0.03	0
1993	877	131961	437	85	352	19.45	15.05	0.50	0.33	0.06	0
1994	897	139738	500	78	422	15.60	15.58	0.56	0.36	0.06	0
1995(P)	910	128414	302	0	302	0.00	14.11	o.33	0.24	0.00	0

24. District : G. Bombay

1985											
1986	9861	546336	833	102	731	12.24	5.54	0.08	0.15	0.02	0
1987	10082	548571	2087	139	1948	6.66	5.44	0.21	0.38	0.03	0
1988	10082	518451	4075	382	3693	9.37	15.14	0.40	0.79	0.07	0
1989	10185	474491	3274	347	2927	10.60	4.66	0.32	0.69	0.07	0
1990	10506	392920	3258	441	2817	13.54	3.74	0.31	0.83	0.11	0
1991	11143	398831	5335	803	4532	15.05	3.58	0.48	1.34	0.20	0
1992	11143	501994	11878	2074	9804	17.46	4.51	1.07	2.37	0.41	0
1993	11143	508214	25171	6135	19036	24.37	4.36	2.26	4.95	1.21	0
1994	11143	493127	21408	3594	17814	16.79	4.43	1.92	4.34	0.73	0
1995(P)	10856	540074	24789	0	24789	0.00	4.97	2.28	4.59	0.00	0

MAHARASHTRA- Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

25. District : Ahmednagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2984	371325	2655	299	2356	11.26	12.44	0.89	0.72	0.08	0
1987	3053	413302	1706	323	1383	18.93	13.54	0.56	0.41	0.08	0
1988	3109	407575	3234	690	2544	21.34	13.11	1.04	0.79	0.17	0
1989	3131	439401	6909	2249	4660	32.55	14.03	2.21	1.57	0.51	0
1990	3168	445895	6420	2381	4039	37.09	14.07	2.03	1.44	0.53	0
1991	3189	514703	9763	2960	6803	30.32	16.14	3.06	1.90	0.58	0
1992	3512	587254	4270	894	3376	20.94	16.72	1.22	0.73	0.15	0
1993	3665	564905	3403	714	2689	20.98	15.41	0.93	0.60	0.13	0
1994	3668	633319	3208	1097	2111	34.20	17.27	0.87	0.51	0.17	0
1995(P)	3689	615981	3158	0	3158	0.00	16.70	0.86	0.51	0.00	0

26. District : Kolhapur

1985											
1986	2753	376878	221	28	193	12.67	13.69	0.08	0.06	0.01	0
1987	2819	395445	142	29	113	20.42	14.03	0.05	0.04	0.01	0
1988	2846	357566	183	53	130	28.96	12.56	0.06	0.05	0.01	0
1989	2902	351574	309	50	259	16.18	12.11	0.11	0.09	0.01	0
1990	2937	367354	178	41	137	23.03	12.51	0.06	0.05	0.01	0
1991	2983	354238	203	55	148	27.09	11.88	0.07	0.06	0.02	0
1992	3061	347270	169	35	134	20.71	11.34	0.06	0.05	0.01	0
1993	3148	349817	214	68	146	31.78	11.11	0.07	0.06	0.02	0
1994	3220	380617	262	81	181	30.92	11.82	0.08	0.07	0.02	0
1995(P)	3270	373573	449	0	449	0.00	11.42	0.14	0.12	0.00	0

27. District : Pune

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	4841	471175	3054	274	2780	8.97	9.73	0.63	0.65	0.06	0
1987	4903	484397	1979	610	1369	30.82	9.88	0.40	0.41	0.13	0
1988	4915	460160	2284	692	1592	30.30	9.36	0.46	0.50	0.15	0
1989	5069	440769	3290	1049	2241	31.88	8.70	0.65	0.75	0.24	0
1990	5070	469993	3238	916	2322	28.29	9.27	0.64	0.69	0.19	0
1991	5382	506179	10170	3370	6800	33.14	9.41	1.89	2.01	0.67	2
1992	5743	596532	13096	3299	9797	25.19	10.39	2.28	2.20	0.55	0
1993	5845	630923	8492	1708	6784	20.11	10.79	1.45	1.35	0.27	0
1994	5845	498241	7848	2143	5705	27.31	8.52	1.34	1.58	0.43	0
1995(P)	4342	523782	12709	0	12709	0.00	12.06	2.93	2.43	0.00	0

28. District : Solapur

1985											
1986	2811	341159	2899	256	2643	8.83	12.14	1.03	0.85	0.08	0
1987	2874	331878	11197	208	989	1.86	11.55	3.90	3.37	0.06	0
1988	2913	334226	2179	473	1706	21.71	11.47	0.75	0.65	0.14	0
1989	2915	332808	2371	364	2007	15.35	11.42	0.81	0.71	0.11	0
1990	2950	355472	1973	424	1549	21.49	14.03	0.93	0.66	0.12	0
1991	3224	376595	1931	421	1510	21.80	15.33	0.51	0.33	0.01	0
1992	3324	394745	2053	349	1704	17.00	11.88	0.62	0.52	0.09	0
1993	3423	396627	1771	315	1456	17.79	11.59	0.52	0.45	0.08	0
1994	3468	394015	2635	768	1867	29.15	11.36	0.76	0.67	0.19	0
1995(P)	3534	408179	1279	0	1279	0.00	11.55	0.36	o.31	0.00	0

29. District : Satara

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2232	281299	3367	329	3038	9.77	12.60	1.51	1.20	0.12	0
1987	2284	300498	2612	364	2248	13.94	13.16	1.14	0.87	0.12	0
1988	2322	300649	3025	349	2676	11.54	12.95	1.30	1.01	0.12	0
1989	2322	313318	2138	358	2280	16.74	13.49	0.92	0.68	0.11	0
1990	2322	309913	1498	241	1257	16.09	13.35	0.65	0.48	0.08	0
1991	2371	305620	2008	372	1636	18.53	12.89	0.85	0.66	0.12	0
1992	2510	334128	2967	308	2659	101.38	13.31	1.18	0.89	0.09	0
1993	2596	330871	2773	359	2414	12.95	12.75	1.07	0.84	0.11	0
1994	2657	343551	2610	557	2053	21.34	12.93	0.98	0.76	0.16	0
1995(P)	2681	368927	3015	0	3015	0.00	13.74	1.12	0.82	0.00	0

30. District : Sangli

1985											
1986	2014	275325	1213	120	1093	9.89	13.67	0.60	0.44	0.04	0
1987	2060	272325	984	106	878	10.77	13.22	0.48	0.36	0.04	0
1988	2097	264750	764	123	641	16.10	12.63	0.36	0.29	0.05	0
1989	2097	261240	640	82	558	12.81	12.46	0.31	0.24	0.03	0
1990	2097	274578	1372	316	1056	23.03	13.09	0.65	0.50	0.12	0
1991	2147	282194	1188	232	956	19.53	13.14	0.55	0.42	0.08	0
1992	2256	310919	1037	182	855	17.55	13.78	0.46	0.33	0.06	0
1993	2329	301099	515	168	347	32.62	12.93	0.22	0.17	0.06	0
1994	2382	315408	702	243	459	34.62	13.24	0.29	0.22	0.08	0
1995(P)	2417	305136	900	0	900	0.00	12.62	0.37	0.29	0.00	0

MANIPUR - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

1. District : Imphal

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	634	52271	506	297	209	58.69	8.24	0.80	0.97	0.57	1
1986	634	61534	410	206	204	50.24	9.71	0.65	0.67	0.33	0
1987	634	59346	334	148	186	44.31	9.36	0.53	0.56	0.25	0
1988	641	59188	244	122	122	50.00	9.23	0.38	0.41	0.21	0
1989	653	61970	248	100	148	40.32	9.49	0.38	0.40	0.16	1
1990	665	57857	164	104	60	63.41	8.70	0.25	0.28	0.18	0
1991	707	61574	164	119	45	72.56	8.71	0.23	0.27	0.19	0
1992	722	61995	492	229	263	46.54	8.59	0.68	0.79	0.37	0
1993	722	59951	746	482	264	64.61	8.30	1.03	1.24	0.80	0
1994	730	34996	1489	952	537	63.94	4.79	2.04	4.25	2.72	12
1995(P)	723	38796	1878	1028	850	54.74	5.37	2.60	4.84	2.65	0

2. District : Thoubal

1985	264	17971	115	58	57	50.43	6.81	0.44	0.64	0.32	0
1986	264	22943	194	45	149	23.20	8.69	0.73	0.85	0.20	0
1987	264	19062	126	15	111	11.90	7.22	0.48	0.66	0.08	0
1988	266	28975	217	38	179	17.51	10.89	0.82	0.75	0.13	0
1989	271	24656	109	35	74	32.11	9.10	0.40	0.44	0.14	0
1990	276	31346	67	11	56	16.42	11.36	0.24	0.21	0.04	0
1991	290	28312	49	10	39	20.41	9.76	0.17	0.17	0.04	0
1992	296	30284	380	137	243	36.05	10.23	1.28	1.25	0.45	0
1993	296	25122	162	32	130	19.75	8.49	0.55	0.64	0.13	0
1994	300	14907	181	37	144	20.44	4.97	0.60	1.21	0.25	2
1995(P)	309	17889	220	49	171	22.27	5.79	0.71	1.23	0.27	0

MANIPUR - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

3. District : Bishenpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	161	11962	9	1	8	11.11	7.43	0.06	0.08	0.01	0
1986	161	10225	30	21	9	70.00	6.35	0.19	0.29	0.21	0
1987	161	11272	8	6	2	75.00	7.00	0.05	0.07	0.05	0
1988	164	12367	22	20	2	90.91	7.54	0.13	0.18	0.16	0
1989	167	15097	48	28	20	58.33	9.04	0.29	0.32	0.19	0
1990	170	14045	34	6	28	17.65	8.26	0.20	0.24	0.04	1
1991	180	14610	56	18	38	32.14	8.12	0.31	0.38	0.12	0
1992	183	12635	200	32	168	16.00	6.90	1.09	1.58	0.25	C
1993	183	14484	278	9	269	3.24	7.91	1.52	1.92	0.06	0
1994	186	8029	177	18	159	10.17	4.32	0.95	2.20	0.22	2
1995(P)	186	5375	145	46	99	31.72	2.89	0.78	2.70	0.86	0

4. District : Ukhrul

1985	95	15436	41	21	20	51.21	16.25	0.43	0.27	0.14	0
1986	95	16384	109	80	29	73.39	17.25	1.15	0.67	0.49	0
1987	99	14686	81	36	45	44.44	14.83	0.82	0.55	0.25	0
1988	97	13705	106	41	65	38.68	14.13	1.09	0.77	0.30	0
1989	99	13232	68	21	47	30.88	13.37	0.69	0.51	0.16	0
1990	101	11678	44	23	21	52.27	11.56	0.44	0.38	0.20	0
1991	110	11237	15	12	3	80.00	10.22	0.14	0.13	0.11	0
1992	112	10787	14	11	3	78.57	9.63	0.13	0.13	0.10	0
1993	112	11215	5	0	5	0.00	10.01	0.04	0.04	0.00	0
1994	115	8545	252	207	45	82.14	7.43	2.19	2.95	2.42	0
1995(P)	115	2829	70	47	23	67.14	2.46	0.61	2.47	1.66	0

MANIPUR - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

5. District : Churachandpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	154	22077	259	209	50	80.69	14.34	1.68	1.17	0.95	0
1986	154	25505	340	185	155	54.41	16.56	2.21	1.33	0.73	0
1987	154	24086	230	66	164	28.70	15.64	1.49	0.95	0.27	0
1988	160	24465	179	104	75	58.10	15.29	1.12	0.73	0.43	1
1989	164	25498	184	105	79	57.07	15.55	1.12	0.72	0.41	1
1990	167	26209	129	98	31	75.97	15.69	0.77	0.49	0.37	0
1991	176	27054	242	138	104	57.02	15.37	1.38	0.89	0.51	0
1992	180	29437	786	452	334	57.51	16.35	4.37	2.67	1.54	0
1993	180	34093	434	175	259	40.32	18.94	2.41	1.27	0.51	0
1994	190	32711	1128	800	328	70.92	17.22	5.94	3.45	2.45	9
1995(P)	195	42127	1006	697	309	69.28	21.60	5.16	2.39	1.65	0

6. District : Chandel

1985	64	11915	160	72	88	45.00	18.62	2.50	1.34	0.60	0
1986	64	11838	187	127	60	67.91	18.50	2.92	1.58	1.07	0
1987	73	9899	61	20	41	32.79	13.56	0.84	0.62	0.20	0
1988	71	11901	107	29	78	27.10	16.76	1.51	0.90	0.24	0
1989	70	15442	93	18	75	19.35	22.06	1.33	0.60	0.12	0
1990	72	13337	67	11	56	16.42	18.52	0.93	0.50	0.08	0
1991	71	12944	56	7	49	12.50	18.23	0.79	0.43	0.05	0
1992	72	11923	90	19	71	21.11	16.56	1.25	0.75	0.16	0
1993	72	10590	67	9	58	13.43	14.71	0.93	0.63	0.08	0
1994	80	5372	257	151	106	58.75	6.72	3.21	4.78	2.81	1
1995(P)	80	7289	130	25	105	19.23	9.11	1.63	1.78	0.34	0

MANIPUR - Districtwise & Yearwise Epidemiological Data & Parameters (1985 - 1995)

7. District : Senapati

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	171	18740	14	1	13	7.14	10.96	0.08	0.07	0.01	0
1986	177	24837	342	207	135	60.53	14.03	1.93	1.38	0.83	0
1987	202	21010	164	56	108	34.15	10.40	0.81	0.78	0.27	0
1988	191	25501	105	48	57	45.71	13.35	0.55	0.41	0.19	0
1989	196	28870	115	61	54	53.04	14.73	0.59	0.40	0.21	0
1990	201	28650	32	8	24	25.00	14.25	0.16	0.11	0.03	0
1991	207	27224	15	8	7	53.33	13.15	0.07	0.06	0.03	0
1992	212	27738	108	28	80	25.93	13.08	0.51	0.39	0.10	0
1993	212	24145	92	47	45	51.09	11.39	0.43	0.38	0.19	0
1994	230	46638	3767	2867	900	76.11	20.28	16.38	8.08	6.15	27
1995(P)	232	13110	573	167	406	29.14	5.65	2.47	4.37	1.27	0

8. District : Tamenglong

1985	71	13246	56	31	25	55.35	18.66	0.79	0.42	0.23	0
1986	71	14799	166	33	133	19.88	20.84	2.34	1.12	0.22	0
1987	80	11953	80	6	74	7.50	14.94	1.00	0.67	0.05	0
1988	74	10688	96	37	59	38.54	14.44	1.30	0.90	0.35	1
1989	76	10879	92	29	63	31.52	14.31	1.21	0.85	0.27	0
1990	77	11446	64	14	50	21.88	14.86	0.83	0.56	0.12	0
1991	85	11195	43	13	30	30.23	13.17	0.51	0.38	0.12	0
1992	89	9940	49	8	41	16.33	11.17	0.55	0.4	0.08	0
1993	89	6636	112	27	85	24.11	7.46	1.26	1.69	0.41	0
1994	90	18569	594	282	312	47.47	20.63	6.60	3.20	1.52	2
1995(P)	99	13427	630	102	528	16.19	13.56	6.36	4.69	0.76	0

MEGHALAYA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

1. District : Khasi Hills

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	768	53469	1017	477	540	46.90	6.96	0.13	1.90	0.89	0
1986	783	64733	1905	1332	573	69.92	8.27	2.43	2.94	2.06	0
1987	806	58218	1901	942	959	49.55	7.22	2.36	3.27	1.62	0
1988	819	56148	2162	1151	1011	53.24	6.86	2.64	3.85	2.05	0
1989	834	54989	1848	1002	846	54.22	6.59	2.22	3.36	1.82	0
1990	864	36846	1036	361	675	34.85	4.26	1.20	2.81	0.98	0
1991	878	47895	1631	838	793	51.38	5.46	1.86	3.41	1.75	0
1992	902	42958	1542	720	822	46.69	4.76	1.71	3.59	1.68	0
1993	922	40563	1891	922	969	48.76	4.40	2.05	4.66	2.27	0
1994	938	53539	3181	2031	1150	63.85	5.71	3.39	5.94	3.79	11
1995(P)	957	93456	7258	4929	2329	67.91	9.77	7.58	7.77	5.27	20

2. District : Jaintia Hills

1985	202	22988	1692	33	1659	1.95	11.37	0.83	7.36	0.14	0
1986	184	29183	1946	123	1823	6.32	15.86	10.58	6.67	0.42	0
1987	188	23715	1515	8	1507	0.53	12.61	8.06	6.39	0.03	0
1988	192	20972	1692	16	1676	0.95	10.92	8.81	8.07	0.08	0
1989	192	22704	1728	30	1698	1.74	11.83	9.00	7.61	0.13	0
1990	225	20824	1498	14	1484	0.93	9.26	6.66	7.19	0.07	0
1991	240	31971	2789	89	2700	3.19	13.32	11.62	8.72	0.28	0
1992	221	31663	3510	27	3483	0.77	14.33	15.88	11.09	0.09	0
1993	263	31703	4005	35	3970	0.87	12.05	15.23	12.63	0.11	0
1994	250	31409	3251	257	2994	7.91	12.56	13.00	10.35	0.82	0
1995(P)	255	39203	9786	394	9392	4.03	15.37	38.38	24.96	1.01	5

MEGHALAYA - Districtwise & Yearwise Epidemiological Data & Parameters (1985 1995)

3. District : Garo Hills

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	563	139221	10836	10163	673	93.79	24.73	19.25	7.78	7.30	0
1987	588	116011	7559	7047	512	93.23	19.73	12.86	6.52	6.07	0
1988	594	122677	8009	7581	428	94.66	20.65	13.48	6.53	6.18	0
1989	628	119205	7125	6735	390	94.53	18.98	11.35	5.98	5.65	0
1990	642	90086	5675	5316	359	93.67	14.03	8.84	6.30	5.90	0
1991	660	129006	6735	6510	225	96.66	19.55	10.20	5.22	5.05	0
1992	685	132288	6231	6116	115	98.15	19.31	9.10	4.71	4.62	0
1993	697	106198	4149	4042	107	97.42	15.24	5.95	3.91	3.81	0
1994	709	115157	5521	5424	97	98.24	16.24	7.79	4.79	4.71	0
1995(P)	723	144433	9543	7358	187	97.52	19.98	10.44	5.22	5.09	7

MIZORAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Aizawl (West)*

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	388	143390	10756	7491	3265	69.64	36.96	27.72	7.50	5.22	0
1987	397	127465	8491	5803	2688	68.34	32.11	21.39	6.66	4.55	0
1988	408	127872	10632	6417	4215	60.36	31.34	26.06	8.31	5.02	14
1989	428	148341	10718	6713	4005	62.63	34.66	25.04	7.23	4.53	17
1990	244	73698	5487	3079	2408	56.11	30.20	22.49	7.45	4.18	7
1991	260	77191	4592	2836	1756	61.76	29.69	17.66	5.95	3.67	11
1992	272	107744	7677	5340	2337	69.56	39.61	28.22	7.13	4.96	0
1993	272	87647	6143	3731	2412	60.74	32.22	22.58	7.01	4.26	0
1994	289	85236	5968	3898	2070	65.32	29.49	20.65	7.00	4.57	33
1995	290	113803	8066	5916	2150	73.34	39.24	27.81	7.09	5.20	44

2. District : Aizawl (East)*

1985	*Seperated 1990										
1986											
1987											
1988											
1989											
1990	192	37802	2671	1360	1311	50.92	19.69	13.91	7.07	3.60	0
1991	207	52459	2455	1328	1127	54.09	25.34	11.86	4.68	2.53	1
1992	207	81203	4479	3124	1355	69.75	39.23	21.64	5.52	3.85	0
1993	207	72212	2641	1620	1021	61.34	34.89	12.76	3.66	2.24	0
1994	215	64166	2606	1646	960	63.16	29.84	12.12	4.06	2.57	8
1995	218	90064	3185	2142	1043	67.25	41.31	14.61	3.54	2.38	6

MIZORAM- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Lunglei

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	84	41685	6954	2221	4733	31.94	49.63	82.79	16.68	5.33	0
1987	87	9468	4928	1634	3294	33.16	45.37	56.64	12.49	414	0
1988	89	44963	6823	1950	4873	28.58	50.52	76.66	15.17	4.34	0
1989	91	44587	4802	1759	3043	36.63	49.00	52.77	10.77	3.95	0
1990	93	32123	3201	1180	2021	36.86	34.54	34.42	9.96	3.67	0
1991	96	32307	3240	1079	2161	33.30	33.65	33.75	10.03	3.34	0
1992	99	43349	5202	2215	2927	42.58	43.79	52.55	12.00	5.11	0
1993	104	0597	2540	862	1678	33.94	29.42	24.42	8.30	2.82	0
1994	108	33094	3373	1346	2027	39.91	30.64	31.23	10.19	4.07	0
1995	109	43060	4227	2237	1990	52.92	39.50	38.78	9.82	5.20	4

4. District : Chhimtuipui

1985											
1986	72	25144	1406	443	963	31.51	34.92	19.53	5.59	1.76	0
1987	72	24253	1937	611	1326	31.54	33.68	26.90	7.99	2.52	0
1988	78	32679	2884	663	2221	22.99	41.90	36.97	8.83	2.03	2
1989	84	39118	2997	736	2261	24.56	46.57	35.68	7.66	1.88	0
1990	89	32193	2464	529	1935	21.47	36.17	27.69	7.65	1.64	1
1991	92	24756	2199	555	1644	25.24	26.91	23.90	8.88	2.24	0
1992	92	7284	3234	685	2549	21.18	29.66	35.15	11.85	2.51	0
1993	92	23902	1842	331	1511	17.97	25.98	20.02	7.71	1.38	0
1994	98	22497	2051	437	1614	21.31	22.96	20.93	9.12	1.94	0
1995	99	24958	2122	476	1646	22.43	25.21	21.43	8.50	1.91	1

NAGALAND- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Kohima

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	303	21453	1843	968	875	52.52	7.08	6.08	8.59	4.51	0
1987	303	19386	2050	1075	975	52.44	6.40	6.77	10.57	5.55	0
1988	326	22956	1888	694	1194	36.76	7.04	5.79	8.22	3.02	0
1989	348	16090	1084	463	621	42.71	4.62	3.11	6.74	29.29	0
1990	496	12057	521	307	214	58.93	2.43	1.05	4.32	2.55	0
1991	496	12444	541	222	319	41.04	2.51	1.09	4.35	1.78	0
1992	412	9939	715	177	538	24.76	2.41	1.74	7.19	1.78	0
1993	446	6043	397	104	293	26.20	1.35	0.89	6.57	1.72	0
1994	446	12790	391	217	174	55.50	2.87	0.88	3.06	1.70	0
1995	455	12797	956	150	806	15.69	2.81	2.10	7.47	1.17	0

2. District : Phek

1985											
1986	78	2068	22	0	22	0.00	2.65	0.28	1.06	0.00	0
1987	78	3235	11	1	10	9.09	4.15	0.14	0.34	0.03	0
1988	78	2808	5	0	5	0.00	3.60	0.06	0.18	0.00	0
1989	78	2401	4	1	3	25.00	3.08	0.05	0.17	0.04	0
1990	78	2126	9	3	6	33.33	2.73	0.12	0.42	0.14	0
1991	78	2126	9	0	9	0.00	2.73	0.12	0.42	0.00	0
1992	85	1967	13	0	13	0.00	2.31	0.15	0.66	0.00	0
1993	89	3090	135	21	114	15.56	3.47	1.52	4.37	0.68	0
1994	89	5305	176	60	116	34.09	5.96	1.98	3.32	1.13	0
1995(P)	90	6262	891	49	842	5.50	6.96	9.90	14.23	0.78	0

NAGALAND- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Wokha

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	74	4418	308	114	194	37.01	5.97	4.16	6.97	2.58	0
1987	74	3196	181	88	93	48.62	4.32	2.45	5.66	2.75	0
1988	74	3890	172	63	109	36.63	5.26	2.32	4.42	1.62	0
1989	74	3843	287	101	186	35.19	5.19	3.88	7.47	2.63	0
1990	83	3254	184	88	96	47.83	3.92	2.22	5.65	2.70	0
1991	83	3783	208	101	107	48.56	4.56	2.51	5.50	2.67	0
1992	85	2629	189	81	108	42.86	3.09	2.22	7.19	3.08	0
1993	90	2424	70	28	42	40.00	2.69	0.78	2.89	1.16	0
1994	91	3850	89	47	42	52.81	4.23	0.98	2.31	1.22	0
1995(P)	92	7496	355	96	259	27.04	8.15	3.86	4.74	1.28	0

4. District : Mokokchung

1985											
1986	147	10364	1966	297	1669	15.11	7.05	13.37	18.97	2.87	0
1987	147	8430	1259	144	1115	11.44	5.73	8.56	14.93	1.71	0
1988	147	7087	798	87	711	10.90	4.82	5.43	11.26	1.23	0
1989	147	7863	710	110	600	15.49	5.35	4.83	9.03	1.40	0
1990	147	6315	717	75	642	10.46	4.30	4.88	11.35	1.19	0
1991	167	6708	750	77	673	10.27	4.02	4.49	11.18	1.15	0
1992	180	5889	584	42	542	7.19	3.27	3.24	9.92	0.71	0
1993	188	4840	390	24	366	6.15	2.57	2.07	8.06	0.50	0
1994	189	7331	367	149	218	40.60	3.88	1.94	5.01	2.03	0
1995(P)	192	12044	926	143	783	15.44	6.27	4.82	7.69	1.19	0

NAGALAND- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : Zunheboto

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	106	5571	272	76	196	27.94	5.26	2.57	4.88	1.36	0
1987	106	4657	240	56	184	23.33	4.39	2.26	5.15	1.20	0
1988	110	4376	192	34	158	17.71	3.98	1.75	4.39	0.78	0
1989	110	3389	154	46	108	29.87	3.08	1.40	4.54	1.36	0
1990	110	5692	263	78	185	29.66	5.17	2.39	4.62	1.37	0
1991	110	5692	247	74	173	29.9	5.17	2.25	4.34	1.30	0
1992	110	5781	284	89	195	31.34	5.26	2.58	4.91	1.54	0
1993	110	4745	248	78	170	31.45	4.31	2.25	5.23	1.64	0
1994	110	14088	176	67	109	38.07	12.81	1.60	1.25	0.48	0
1995(P)	112	7860	382	77	305	20.16	7.02	3.41	4.86	0.98	0

6. District : Mon

1985											
1986	99	5578	1208	450	758	37.25	5.63	12.20	21.66	8.07	0
1987	99	3829	584	145	439	24.83	3.87	5.90	15.25	3.79	0
1988	100	2117	102	29	73	28.43	2.12	1.02	4.82	1.37	0
1989	120	3023	218	69	149	31.65	2.52	1.82	7.21	2.28	0
1990	140	2454	135	37	98	27.41	1.75	0.96	5.50	1.51	0
1991	150	2563	139	37	102	26.62	1.71	0.93	5.42	1.44	0
1992	161	2619	64	24	40	37.50	1.63	0.40	2.44	0.92	0
1993	170	1740	61	24	37	39.34	1.02	0.36	3.51	1.38	0
1994	173	7435	372	173	199	46.51	4.30	2.15	5.00	2.33	0
1995(P)	176	10780	677	155	522	22.90	6.13	3.85	6.28	1.44	0

NAGALAND- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Tuensang

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	160	9358	698	117	581	16.76	5.85	4.36	7.46	1.25	0
1987	160	7218	675	54	621	8.00	4.51	4.22	9.35	0.75	0
1988	160	7529	587	47	540	8.01	4.71	3.67	7.80	0.62	0
1989	161	7298	594	543	51	91.41	4.53	3.69	8.14	7.44	0
1990	190	5412	498	21	477	4.22	2.85	2.62	9.20	0.39	0
1991	190	6310	528	22	506	4.17	3.32	2.78	8.37	0.35	0
1992	195	4810	369	19	350	5.15	2.47	1.89	7.67	0.40	0
1993	199	4073	283	5	278	1.77	2.05	1.42	6.95	0.12	0
1994	201	11415	292	80	212	27.40	5.68	1.45	2.56	0.70	0
1995(P)	205	9394	607	102	505	16.80	4.58	2.96	6.46	1.09	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District: Balasore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1886	2456	223444	4536	2713	1823	59.81	9.10	1.85	2.03	1.21	0
1987	2520	244403	2792	1521	1271	54.48	9.70	1.11	1.14	0.62	0
1988	2615	231790	2603	1146	1457	44.03	8.86	1.00	1.12	0.49	3
1989	2667	250424	2018	839	1179	41.58	9.39	0.76	0.81	0.34	3
1990	2719	244340	3243	2255	988	69.53	8.99	1.19	1.33	0.92	5
1991	2796	268718	4093	2918	1175	71.29	9.61	1.46	1.52	1.09	2
1992	2796	278328	3761	2739	1022	72.83	9.95	1.35	1.35	0.98	0
1993	1033	88225	238	66	172	27,73	8.54	0.23	0.27	0.07	0
1994	1839	153723	2505	1928	577	76.97	8.36	1.36	1.63	1.25	0
1995(P)	1877	145401	3060	2476	584	80.92	7.75	1.63	2.10	1.70	0

2. District : Bolangir

1985											
1986	1416	143411	15782	11223	4559	71.11	10.13	11.15	11.00	7.83	0
1987	1440	124685	7312	4591	2721	62.79	8.66	5.08	5.86	3.68	0
1988	1440	112884	3513	2300	1213	65.47	7.84	2.44	3.11	2.04	0
1989	1650	120915	5666	3929	1737	69.34	7.33	3.43	4.69	3.25	7
1990	1660	133034	7970	5368	2602	67.35	8.01	4.80	5.99	4.04	9
1991	1703	222429	28940	20376	8564	70.41	13.06	16.99	13.01	9.16	8
1992	1703	161936	15201	9323	5878	61.33	9.51	8.93	9.93	5.76	0
1993	1227	110704	9661	6832	2829	70.72	9.02	7.87	7.87	6.17	0
1994	1159	119868	11134	8527	2607	76.59	10.34	9.61	9.61	7.11	0
1995(P)	1183	127085	15602	11799	3803	75.62	10.74	13.19	12.28	9.28	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Cuttack

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	5015	261816	3562	1653	1909	46.41	5.22	0.71	1.36	0.63	0
1987	5015	297325	1506	626	880	41.57	5.93	0.30	0.51	0.21	0
1988	5015	287304	1590	544	1046	34.21	5.73	0.32	0.55	0.19	3
1989	5015	299517	1691	901	790	53.28	5.97	0.33	0.56	0.30	9
1990	5348	309614	4284	2150	2134	50.19	5.79	0.80	1.38	0.69	15
1991	5502	325955	5434	3114	2320	57.31	5.92	0.99	1.67	0.96	23
1992	5503	338843	4553	2742	1811	60.22	6.16	0.83	1.34	0.81	0
1993	2043	118029	2419	1988	431	82.18	5.78	1.18	2.05	1.68	0
1994	2096	118797	2533	2176	357	85.91	5.67	1.21	2.13	1.83	0
1995(P)	2140	105857	2822	2366	456	83.84	4.95	1.32	2.67	2.24	0

4. District : Dhenkanal

1985											
1986	1698	198209	24507	17560	6947	71.65	11.67	14.43	12.36	8.86	0
1987	1724	200463	19885	15327	4558	77.08	11.63	11.53	9.92	7.65	0
1988	1830	171037	13259	10341	2918	77.99	9.35	7.25	7.75	6.05	2
1989	1830	234690	23843	19347	4496	81.14	12.82	13.03	10.16	8.24	9
1990	1830	247718	31365	24067	7298	76.73	13.53	17.13	12.66	9.72	10
1991	1830	277557	38693	30705	7988	79.36	15.16	21.14	13.94	11.06	19
1992	1900	275277	44083	33564	10519	76.14	14.49	23.20	16.01	12.19	0
1993	959	112650	16849	11919	4930	70.74	11.75	17.57	14.96	10.58	0
1994	922	131034	22143	15425	6718	69.66	14.21	24.02	16.90	11.77	0
1995(P)	941	113548	20225	14032	6193	69.38	12.07	21.49	17.81	12.36	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : Ganjam

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2887	293045	38301	30235	8066	78.94	10.15	13.27	13.07	10.32	0
1987	2887	292986	24052	19504	4548	81.09	10.15	8.33	8.21	6.66	0
1988	2887	313412	20472	17061	3411	83.34	10.86	7.09	6.53	5.44	2
1989	3036	334503	29742	24863	4879	83.60	11.02	9.80	8.89	7.43	9
1990	3036	352360	32370	26611	57.59	11.61	10.66	9.19	7.55	10.00	0
1991	3036	382630	30524	26283	4241	86.11	12.60	10.05	7.98	6.87	11
1992	3144	361220	27725	23449	4276	84.58	11.49	8.82	7.68	6.49	0
1993	2650	220196	16038	13057	2981	81.41	8.31	6.05	7.28	5.93	0
1994	2860	202308	14458	11892	2566	82.25	7.07	5.06	7.15	5.88	0
1995(P)	2920	165494	11382	9460	1922	83.11	5.67	3.90	6.88	5.72	0

6. District : Keonjhar

1985											
1986	1162	212198	36504	30610	5894	83.85	18.26	31.41	17.20	14.43	0
1987	1226	228054	27000	22906	4094	84.84	18.60	22.02	11.84	10.04	0
1988	1244	263229	29657	25906	3751	87.35	21.16	23.84	11.27	9.84	17
1989	1244	281601	30149	28075	2074	93.12	22.64	24.24	10.71	9.97	12
1990	1272	297089	39817	37998	1819	95.43	23.36	31.30	13.40	12.79	13
1991	1272	388733	62325	58670	3655	94.14	30.56	49.00	16.03	15.09	42
1992	1315	351636	56422	53193	3229	94.17	26.74	42.91	16.05	15.11	0
1993	1336	322675	53977	50677	3300	93.89	24.15	40.40	16.73	15.71	0
1994	1435	343629	55192	52751	2441	95.58	23.95	38.46	16.06	15.35	0
1995(P)	1465	317889	49931	47364	2567	94.86	21.70	34.08	15.71	14.90	0

7. District : Koraput

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2769	280723	39559	34497	5062	87.20	10.14	14.29	14.09	12.29	0
1987	2769	300958	37277	34136	3141	91.57	10.87	13.46	12.39	11.34	0
1988	2769	298105	34559	32043	2516	92.72	10.77	12.48	11.59	10.75	3
1989	2769	345122	39173	36439	2734	93.02	12.65	14.36	11.35	10.56	13
1990	2771	340436	35448	33858	1590	95.51	12.29	12.79	10.41	9.95	11
1991	2999	487693	58075	54010	4065	93.00	16.26	19.36	11.91	11.07	19
1992	2999	441315	51002	47793	3209	93.71	14.72	17.01	11.56	10.83	0
1993	946	136552	15925	14983	942	94.08	14.43	16.83	11.66	10.97	0
1994	953	118173	14997	14300	697	95.35	12.40	15.74	12.69	12.10	0
1995(P)	973	127737	13694	13395	299	97.82	13.13	14.07	10.72	10.49	0

8. District : Kalahandi

1985											
1986	1436	146893	11126	8708	2418	78.27	10.23	7.75	7.57	5.93	0
1987	1505	165244	10512	7512	3000	71.46	10.98	6.98	6.36	4.55	0
1988	1538	153424	8897	6370	2527	71.60	9.98	5.78	5.80	4.15	2
1989	1538	185389	12783	10208	2575	79.86	12.05	8.31	6.90	5.51	4
1990	1538	185127	15700	11347	4353	72.27	12.04	10.21	8.48	6.13	13
1991	1538	232554	26385	18717	7668	70.94	15.12	17.10	11.35	8.05	16
1992	1591	239499	26523	19969	6554	75.29	15.05	16.67	11.07	8.34	0
1993	1056	155306	13895	10301	3594	74.13	14.71	13.16	8.95	6.63	0
1994	1176	117337	10607	7578	3029	71.44	9.98	9.02	9.04	6.46	0
1995(P)	1200	101323	9561	7708	1853	80.62	8.44	7.97	9.44	7.61	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : Mayurbhanj

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1684	260064	34905	26414	8491	75.67	15.44	20.73	13.42	10.16	0
1987	1684	277487	27289	21187	6102	77.64	16.84	16.20	9.83	7.64	0
1988	1695	239971	25723	20113	5610	78.19	14.16	15.18	10.72	8.38	14
1989	1695	245575	29198	23367	5831	85.91	14.49	17.23	11.89	9.52	11
1990	1700	269049	34131	28008	6123	82.06	15.83	20.08	12.69	10.41	17
1991	1700	342104	48991	40989	8002	83.67	20.12	28.82	14.32	11.98	25
1992	1871	315503	34547	28300	6247	81.92	16.86	18.46	10.95	8.97	0
1993	1872	291452	32775	28542	4233	87.08	15.57	17.51	11.25	9.79	0
1994	2001	288192	33062	29452	3610	89.08	14.40	16.52	11.47	10.22	0
1995(P)	2043	393598	44739	39750	4989	88.88	19.27	21.90	11.37	10.10	0

10. District : Puri

1985											
1986	3043	232169	9061	5235	3826	57.78	7.63	2.98	3.90	2.25	0
1987	3048	291713	9771	5141	4657	52.61	9.57	3.21	3.35	1.76	0
1988	3048	269663	7013	4024	2989	57.38	8.85	2.30	2.60	1.49	11
1989	3048	278235	8605	5911	2694	68.69	9.13	2.82	3.09	2.12	4
1990	3048	256351	7773	4973	2800	63.98	8.41	2.55	3.03	1.94	16
1991	3570	247512	11448	6382	5066	55.75	6.93	3.21	4.63	2.58	10
1992	3570	235681	10363	5712	4651	55.12	6.60	2.90	4.40	2.42	0
1993	1296	54082	449	19	430	4.23	4.17	0.35	0.83	0.04	0
1994	1195	64676	687	34	653	4.95	5.41	0.57	1.06	0.05	0
1995(P)	1220	56559	792	34	758	4.29	4.64	0.65	1.40	0.06	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Phulbani

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	770	181329	33490	28332	5158	84.60	23.55	43.49	18.47	15.62	0
1987	791	161713	21788	18008	3780	82.65	20.44	27.54	13.47	11.14	0
1988	793	145659	17251	15021	2230	87.07	18.37	21.75	11.84	10.31	5
1989	818	190918	21418	19085	2333	89.11	23.34	26.18	11.22	10.00	18
1990	841	181994	21392	18960	2432	88.63	21.64	25.44	11.75	10.42	19
1991	858	226868	30740	27052	3688	88.00	26.44	35.83	13.55	11.92	14
1992	858	206084	27295	24764	2531	90.73	24.02	31.81	13.24	12.02	0
1993	915	175930	26355	24090	2265	91.41	19.23	28.80	14.98	13.69	0
1994	915	166834	27432	24948	2484	90.94	18.23	29.98	16.44	14.95	0
1995(P)	934	129719	24063	20293	3770	84.33	13.89	25.76	18.55	15.64	0

12. District : Sambalpur

1985											
1986	2474	236894	25547	20398	5149	79.84	9.58	10.33	10.78	8.61	0
1987	2474	236269	17705	4502	13203	25.43	9.55	7.16	7.49	1.91	0
1988	2474	206941	12013	9096	2917	75.72	8.36	4.86	5.81	4.40	7
1989	2974	231128	14202	12052	2150	84.86	9.34	5.74	6.14	5.21	6
1990	2691	237333	15141	12529	2612	82.75	8.82	5.63	6.38	5.28	3
1991	2691	255141	19485	17391	2094	89.25	9.48	7.24	7.64	6.82	19
1992	2691	240034	18309	16363	1946	89.37	8.52	6.80	7.63	6.82	0
1993	1485	169005	17983	15924	2059	88.55	11.38	12.11	10.64	9.42	0
1994	843	105570	8884	7619	1265	85.76	12.52	10.54	8.42	7.22	0
1995(P)	860	145359	15095	13384	1711	88.67	16.90	17.55	10.38	9.21	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

13. District : Sunergarh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1425	248987	39259	35433	3826	90.25	17.47	27.55	15.77	14.23	0
1987	1481	251625	30921	28124	2797	90.95	16.99	20.88	12.29	11.18	0
1988	1481	183681	29518	26884	2634	91.08	12.40	19.93	16.07	14.64	13
1989	1563	282594	42327	38358	3969	90.62	18.08	27.08	14.98	13.57	15
1990	1565	291251	41481	37687	3794	90.85	18.63	26.54	14.24	12.94	12
1991	1568	304877	49417	44556	4861	90.16	19.44	31.52	16.21	14.61	25
1992	1568	301682	42606	39207	3399	92.02	19.24	27.17	14.12	13.00	0
1993	1568	267538	32996	30554	2442	92.60	17.06	21.04	12.33	11.42	0
1994	2125	268367	33053	30768	2285	93.09	12.63	15.55	12.32	11.46	0
1995(P)	2169	320327	43759	40859	2905	93.36	14.77	20.17	13.66	12.75	0

14. District : Raygada

1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	697	103317	13216	12002	1214	90.81	14.82	18.96	12.79	11.62	0
1994	769	96128	12920	11919	1001	92.25	12.50	16.80	13.44	12.40	0
1995(P)	785	103674	13774	12810	964	93.00	13.21	17.55	13.29	12.36	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

15. District : Malkangiri

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	452	53883	6781	6471	310	95.43	11.92	15.00	12.58	12.01	0
1994	452	58840	5731	5595	136	97.63	13.02	12.68	9.74	9.51	0
1995(P)	461	75199	7574	7461	113	98.51	16.31	16.43	10.07	9.92	0

16. District : Nawrangpur

1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	810	93378	9569	9230	339	96.46	11.53	11.81	10.25	9.88	0
1994	810	81022	9279	9152	127	98.63	10.00	11.46	11.45	11.30	0
1995(P)	827	98636	10038	9963	75	99.25	11.93	12.14	10.18	10.10	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

17. District : Khurda

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	1498	67999	1800	501	1299	27.83	4.54	1.20	2.65	0.74	0
1994	1498	69571	2087	749	1338	35.89	4.64	1.39	3.00	1.08	0
1995(P)	1529	60680	1500	498	1002	3320	3.97	0.98	2.47	0.82	0

18. District : Nayagarh

1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	777	76986	5213	3399	1814	65.20	9.91	6.71	6.77	4.42	0
1994	777	78578	5773	4489	1284	77.76	10.11	7.43	7.35	5.71	0
1995(P)	793	70103	6549	4933	1616	75.32	8.84	8,26	9.34	7.04	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

19. District : Bargarh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	1204	64516	1838	1505	333	81.88	5.36	1.53	2.85	2.33	0
1994	1204	63203	2300	2025	275	88.04	5.25	1.91	3.64	3.20	0
1995(P)	1229	85365	6995	6029	966	86.19	6.95	5.69	8.19	7.06	0

20. District : Nawapada

1985	New distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	453	49297	7701	5249	2452	68.16	10.88	17.00	15.62	10.65	0
1994	453	48868	9073	6517	2556	71.83	10.79	20.03	18.57	13.34	0
1995(P)	462	54877	9718	6829	2889	70.27	11.88	21.03	17.71	12.44	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

21. District : Sonepur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	476	43888	5069	2251	2818	44.41	9.22	10.65	11.55	5.13	0
1994	476	46154	5329	1969	3360	36.95	9.70	11.20	11.55	4.27	0
1995(P)	485	59818	6328	2300	4028	36.35	12.33	13.05	10.58	3.84	0

22. District : Angul

1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	884	105721	16605	11977	4628	72.13	11.96	18.78	15.71	11.33	0
1994	1053	113897	18809	13614	5195	72.38	10.82	17.86	16.51	11.95	0
1995(P)	1075	104638	17453	12591	4862	72.14	9.73	16.24	16.68	12.03	0

Orissa - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

23. District : Bhadrak

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	1634	175848	2648	1977	671	74.66	10.76	1.62	1.51	1.12	0
1994	1159	85340	403	133	270	33.00	7.36	0.35	0.47	0.16	0
1995(P)	1183	65498	410	185	225	45.12	5.54	0.35	0.63	0.28	0

24. District : Gajapati

1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	477	82348	11414	10447	967	91.53	17.26	23.93	13.86	12.69	0
1994	477	66097	9451	8777	674	92.87	13.86	19.81	14.30	13.28	0
1995(P)	487	65957	9546	8705	841	91.19	13.54	19.60	14.47	13.20	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

25. District : Jajpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	1380	79703	1887	924	963	48.97	5.78	1.37	2.37	1.16	0
1994	1380	82638	2342	1261	1081	53.84	5.99	1.70	2.83	1.53	0
1995(P)	1408	62111	2674	1074	1600	40.16	4.41	1.90	4.31	1.73	0

26. District : Jagatasinghpur

1985	New Distt. created in 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	933	52142	65	28	37	43.08	5.59	0.07	0.12	0.05	0
1994	939	49824	115	39	76	33.91	5.31	0.12	0.23	0.08	0
1995(P)	958	36819	118	46	72	38.98	3.84	0.12	0.32	0.12	0

ORISSA - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

27. District : Kendrapada

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created on 1993										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	1146	49148	210	34	176	16.19	4.29	0.18	0.43	0.07	0
1994	1224	51919	356	146	210	41.01	4.24	0.29	0.69	0.28	0
1995(P)	1249	48670	254	91	163	35.83	3.90	0.20	0.52	0.19	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District: Amritsar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2625	349655	10515	643	9872	6.12	13.32	4.01	3.01	0.18	0
1987	2625	291365	5246	21	5225	0.40	11.10	2.00	1.80	0.01	0
1988	2576	269362	1985	40	1945	2.02	10.46	0.77	0.74	0.01	0
1989	2623	258807	2818	18	2800	0.64	9.87	1.07	1.09	0.01	0
1990	2672	226297	1716	1	1715	0.06	8.47	0.64	0.76	0.00	0
1991	2722	284073	2091	3	2088	0.14	10.44	0.77	0.74	0.00	0
1992	2751	283044	1744	12	1732	0.69	10.29	0.63	0.62	0.00	0
1993	2811	278798	1220	8	1212	0.66	9.92	0.43	0.44	0.00	0
1994	2860	297648	2004	4	2000	0.20	10.41	0.70	0.67	0.00	0
1995	2903	324338	2676	224	2452	8.37	11.17	0.92	0.83	0.07	8

2. District : Bhatinda

1985											
1986	1489	235846	12574	786	11788	6.25	15.84	8.44	5.33	0.33	0
1987	1489	182017	6307	73	6234	1.16	12.22	4.24	3.47	0.04	0
1988	1502	143478	1502	1	1501	0.07	9.55	1.00	1.05	0.00	0
1989	1528	128127	770	3	767	0.39	8.39	0.50	0.60	0.00	0
1990	1551	107329	683	1	682	0.15	6.92	0.44	0.64	0.00	0
1991	1577	151819	887	9	878	1.01	9.63	0.56	0.58	0.01	0
1992	979	95448	244	1	243	0.41	9.75	0.25	0.26	0.00	0
1993	994	104506	142	0	142	0.00	10.51	0.14	0.14	0.00	0
1994	1019	116967	157	0	157	0.00	11.48	0.15	0.13	0.00	0
1995	1036	109332	236	0	236	0.00	10.55	0.23	0.22	0.00	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District: Faridkot

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1626	219837	10939	774	10165	7.08	13.52	6.73	4.98	0.35	0
1987	1626	190337	4769	102	4667	2.14	11.71	2.93	2.51	0.05	0
1988	1628	154322	1841	5	1836	0.27	9.48	1.13	1.19	0.00	0
1989	1697	147345	1031	1	1030	0.10	8.68	0.61	0.70	0.00	0
1990	1697	144781	713	1	712	0.14	8.53	0.42	0.49	0.00	0
1991	1722	147345	534	1	533	0.19	8.56	0.31	0.36	0.00	0
1992	1747	164128	407	2	405	0.49	9.39	0.23	0.25	0.00	0
1993	1793	163044	354	0	354	0.00	9.09	0.20	0.22	0.00	0
1994	1821	171219	561	4	557	0.71	9.40	0.31	0.33	0.00	0
1995	1858	158102	1169	4	1165	0.34	8.51	0.63	0.74	0.00	0

4. District : Ferozepur

1985											
1986	1529	216850	4640	264	4376	5.69	14.18	3.03	2.14	0.12	0
1987	1529	222292	1824	39	1785	2.14	14.54	1.19	0.82	0.02	0
1988	1529	218623	345	4	341	1.16	14.29	0.22	0.16	0.00	0
1989	1529	200000	401	0	401	0.00	13.08	0.26	0.20	0.00	0
1990	1560	192450	337	0	337	0.00	12.34	0.22	0.18	0.00	0
1991	1595	193492	388	0	388	0.00	12.13	0.24	0.20	0.00	0
1992	1631	188390	548	5	543	0.91	11.55	0.34	0.29	0.00	0
1993	1691	182627	650	13	637	2.00	10.80	0.38	0.36	0.01	0
1994	1725	182140	436	2	434	0.46	10.56	0.25	0.24	0.00	0
1995	1757	187493	750	4	746	0.53	10.67	0.43	0.40	0.00	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District: Gurdaspur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1770	273162	23525	441	23084	1.87	15.43	13.29	8.61	0.16	0
1987	1770	238867	10755	68	10687	0.63	13.50	6.08	4.50	0.03	0
1988	1769	231268	4287	49	4238	1.14	13.07	2.42	1.85	0.02	0
1989	1802	220084	5333	34	5299	0.64	12.21	2.96	2.42	0.02	0
1990	1839	197289	3755	27	3728	0.72	10.73	2.04	1.90	0.01	0
1991	1884	212831	5876	9	5867	0.15	11.30	3.12	2.76	0.00	0
1992	1898	207836	3627	8	3619	0.22	10.95	1.91	1.75	0.00	0
1993	1929	205790	3160	3	3157	0.09	10.67	1.64	1.54	0.00	0
1994	1970	228632	2096	10	2086	0.48	11.61	1.06	0.92	0.00	0
1995	1992	252278	4061	18	4043	0.44	12.66	2.04	1.61	0.01	0

6. District : Hoshiarpur

1985											
1986	1390	218480	13689	558	13131	4.08	15.72	9.85	6.27	0.26	0
1987	1390	178856	8430	28	8402	0.33	12.87	6.06	4.71	0.02	0
1988	1420	197855	1889	51	1838	2.70	13.93	1.33	0.95	0.03	0
1989	1449	175403	1986	30	1956	1.51	12.11	1.37	1.13	0.02	0
1990	1472	160345	2357	17	2340	0.72	10.89	1.60	1.47	0.01	0
1991	1491	185201	2522	12	2510	0.48	12.42	1.69	1.36	0.01	0
1992	1532	191460	1161	9	1152	0.78	12.50	0.76	0.61	0.00	0
1993	1552	182627	650	13	637	2.00	11.77	0.42	0.36	0.01	0
1994	1542	173446	759	6	753	0.79	11.25	0.49	0.44	0.00	0
1995	1992	252278	4061	18	4043	0.44	12.66	2.04	1.61	0.01	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Jallandhar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1899	277781	10832	1022	9810	9.44	14.63	5.70	3.90	0.37	0
1987	1946	241072	5992	67	5925	1.12	12.39	3.08	2.49	0.03	0
1988	1965	236420	2301	32	2269	1.39	12.03	1.17	0.97	0.01	0
1989	1994	211855	2384	11	2373	0.46	10.62	1.20	1.13	0.01	0
1990	2024	208225	2580	18	2562	0.70	10.29	1.27	1.24	0.01	0
1991	2052	268674	2885	4	2881	0.14	13.09	1.41	1.07	0.00	0
1992	2085	251257	2132	2	2130	0.09	12.05	1.02	0.85	0.00	0
1993	2103	251801	960	3	957	0.31	11.97	0.46	0.38	0.00	0
1994	2138	248121	1322	3	1319	0.23	11.61	0.62	0.53	0.00	0
1995	2168	240324	1869	2	1867	0.11	11.09	0.86	0.78	0.00	0

8. District : Kapurthala

1985											
1986	629	87565	5735	285	5450	4.97	13.92	9.12	6.55	0.33	0
1987	629	72222	3156	3	3153	0.10	11.48	5.02	4.37	0.00	0
1988	638	72498	1542	6	1636	0.39	11.36	2.42	2.13	0.01	0
1989	642	76809	2141	2	2139	0.09	11.96	3.33	2.79	0.00	0
1990	650	65475	2073	3	2070	0.14	10.07	3.19	3.17	0.00	0
1991	663	76050	2277	1	2276	0.04	11.47	3.43	2.99	0.00	0
1992	673	72376	1487	3	1484	0.20	10.75	2.21	2.05	0.00	0
1993	660	69703	1044	3	1041	0.29	10.56	1.58	1.50	0.00	0
1994	675	81123	525	1	524	0.19	12.02	0.78	0.65	0.00	0
1995	688	74115	1793	3	1790	0.17	10.77	2.61	2.42	0.00	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District: Ludhiana

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2124	404082	12080	638	11442	5.28	19.02	5.69	2.99	0.16	0
1987	2124	322290	7478	21	7457	0.28	15.17	3.52	2.32	0.01	0
1988	2129	304825	2929	11	2918	0.38	14.32	1.38	0.96	0.00	0
1989	2160	282432	2691	9	2682	0.33	13.08	1.25	0.95	0.00	0
1990	2201	246889	2343	6	2337	0.26	11.22	1.06	0.95	0.00	0
1991	2229	283870	2879	4	2875	0.14	12.74	1.29	1.01	0.00	0
1992	2520	297986	1498	6	1492	0.40	11.82	0.59	0.50	0.00	0
1993	2485	266905	673	1	672	0.15	10.74	0.27	0.25	0.00	0
1994	2521	255097	778	0	778	0.00	10.12	0.31	0.30	0.00	0
1995	2550	270456	1078	3	1075	0.28	10.61	0.42	0.40	0.00	0

10. District : Patiala

1985											
1986	1775	417635	23123	2217	20906	9.59	23.53	13.03	5.54	0.53	0
1987	1775	359169	11634	124	11510	1.07	20.23	6.55	3.24	0.03	0
1988	1805	360542	4485	260	4225	5.80	19.97	2.48	1.24	0.07	0
1989	1842	359936	6432	663	5769	10.31	19.54	3.49	1.79	0.18	0
1990	1878	324035	5283	426	4857	8.06	17.25	2.81	1.63	0.13	0
1991	1907	361588	7972	302	7670	3.79	18.96	4.18	2.20	0.08	0
1992	1572	254688	4998	80	4918	1.60	16.20	3.18	1.96	0.03	0
1993	1599	249809	3286	19	3267	0.58	15.62	2.06	1.32	0.01	0
1994	1658	272109	3619	135	3484	3.73	16.41	2.18	1.33	0.05	0
1995	1684	260689	7528	1598	5930	21.23	15.48	4.47	2.89	0.61	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Ropar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	851	191216	22415	324	22091	1.45	22.47	26.34	11.72	0.17	0
1987	851	172448	12225	27	12198	0.22	20.26	14.37	7.09	0.02	0
1988	897	198147	7143	19	7124	0.27	22.09	7.96	3.60	0.01	0
1989	897	140873	3566	19	3547	0.53	15.70	3.97	2.53	0.01	0
1990	897	155595	4366	39	4327	0.89	17.35	4.87	2.81	0.03	0
1991	967	174060	5389	17	5372	0.32	18.00	5.57	3.10	0.01	0
1992	967	172164	3006	24	2982	0.80	17.80	3.11	1.75	0.01	0
1993	1007	161593	1567	6	1561	0.38	16.05	1.56	0.97	0.00	0
1994	1007	163338	1048	8	1040	0.76	16.22	1.04	0.64	0.00	0
1995	1007	166062	1195	12	1183	1.00	16.49	1.19	0.72	0.01	0

12. District : Sangrur

1985											
1986	1582	365844	23945	5162	18783	21.56	23.13	15.14	6.55	1.41	0
1987	1582	228032	8788	289	8499	3.29	14.41	5.55	3.85	0.13	0
1988	1611	241913	3093	148	2945	4.78	15.02	1.92	1.28	0.06	0
1989	1658	241306	2593	43	2550	1.66	14.55	1.56	1.07	0.02	0
1990	1686	198029	3130	40	3090	1.28	11.75	1.86	1.58	0.02	0
1991	1738	255393	2949	3	2946	0.10	14.69	1.70	1.15	0.00	0
1992	1786	129810	1054	2	1052	0.19	7.27	0.59	0.81	0.00	0
1993	1810	227504	916	2	914	0.22	12.57	0.51	0.40	0.00	0
1994	1835	225169	1144	7	1137	0.61	12.27	0.62	0.51	0.00	0
1995	1869	232851	3574	1482	2092	41.47	12.46	1.91	1.53	0.64	0

PUNJAB - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

13. District : Fathehgarh Saheb

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985	New distt. created in 1992										
1986											
1987											
1988											
1989											
1990											
1991											
1992	380	61750	1051	30	1021	2.85	16.25	2.77	1.70	0.05	0
1993	476	80959	809	2	807	0.25	17.01	1.70	1.00	0.00	0
1994	483	80480	842	4	838	0.48	16.66	1.74	1.05	0.00	0
1995	493	70849	511	1	510	0.20	14.37	1.04	0.72	0.00	0

14. District : Mansa

1985	New Distt. created in 1992										
1986											
1987											
1988											
1989											
1990											
1991											
1992	622	65548	268	0	268	0.00	10.54	0.43	0.41	0.00	0
1993	629	68850	428	0	428	0.00	10.95	0.68	0.62	0.00	0
1994	641	70202	310	1	309	0.32	10.95	0.48	0.44	0.00	1
1995	651	75163	800	2	798	0.25	11.55	1.23	1.06	0.00	0

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Ajmer

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1491	108487	2128	460	1668	21.62	7.28	1.43	1.96	0.42	0
1987	1491	125917	1298	205	1093	15.79	8.45	0.87	1.03	0.16	0
1988	1491	135417	3696	490	3206	13.26	9.08	2.48	2.73	0.36	0
1989	1491	121109	4196	364	3832	8.67	8.12	2.81	3.46	0.30	0
1990	1491	139316	3370	646	2724	19.17	9.34	2.26	2.42	0.46	0
1991	1723	124400	3416	392	3024	11.48	7.22	1.98	2.75	0.32	0
1992	1723	137354	4940	1281	3659	25.93	7.97	2.86	3.59	0.93	0
1993	1729	138639	4434	227	4207	5.12	8.02	2.56	3.19	16.00	0
1994	1729	187133	11511	3134	8377	27.23	10.82	6.66	6.15	1.67	22
1995	1729	193416	8352	1246	7106	14.92	11.19	4.83	4.32	0.64	5

2. District : Alwar

1985											
1986	1622	90667	2476	107	2369	4.32	5.59	1.53	2.73	0.12	0
1987	1983	112057	2849	57	2792	2.00	5.65	1.44	2.54	0.05	0
1988	1983	152637	5170	543	4627	10.50	7.70	2.61	3.39	0.36	0
1989	1983	148242	3954	266	3688	6.73	7.48	1.99	2.67	0.18	0
1990	1983	181976	2432	154	2278	6.33	9.18	1.23	1.34	0.08	0
1991	2287	166701	898	66	832	7.35	7.29	0.39	0.54	0.04	0
1992	2287	213011	890	167	723	18.76	9.31	0.39	0.42	0.08	0
1993	2297	200812	977	96	881	9.83	8.74	0.43	0.49	0.05	0
1994	2297	210936	2054	436	1618	21.22	9.18	0.89	0.97	0.21	0
1995	2297	278534	8347	1505	6842	18.03	12.13	3.63	3.00	0.54	1

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Bharatpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1384	84757	2486	412	2074	16.57	6.12	1.80	2.93	0.49	0
1987	1384	83286	484	75	409	15.50	6.02	0.35	0.58	0.09	0
1988	1384	113702	1112	187	925	16.82	8.22	0.80	0.98	0.16	0
1989	1384	81640	808	127	681	15.72	5.90	0.58	0.99	0.16	0
1990	1384	110400	1814	724	1090	39.91	7.98	1.31	1.64	0.66	0
1991	1646	105284	2808	369	2439	13.14	6.40	1.71	2.67	0.35	2
1992	1647	188516	13763	3540	10223	25.72	11.45	8.36	7.30	1.88	0
1993	1652	134604	12293	1822	10471	14.82	8.15	7.44	9.13	1.35	0
1994	1652	164613	9532	1543	7989	16.18	9.96	5.77	5.79	0.93	1
1995	1652	319728	24337	8835	15502	36.60	19.35	14.73	7.61	2.76	5

4. District : Dholpur

1985											
1986	585	60840	189	111	1078	9.33	10.40	2.03	1.95	0.18	0
1987	585	48607	356	28	328	7.87	8.31	0.61	0.73	0.06	0
1988	585	55649	328	63	265	19.21	9.51	0.56	0.59	0.11	0
1989	585	58493	546	83	463	15.20	10.00	0.93	0.93	0.14	0
1990	585	63601	598	176	422	29.43	10.87	1.02	0.94	0.28	0
1991	748	67868	422	150	272	35.55	9.07	0.56	0.62	0.22	0
1992	748	87311	515	201	314	39.03	11.67	0.69	0.59	0.23	0
1993	749	64525	648	100	548	15.43	8.61	0.87	1.00	0.15	0
1994	749	76183	686	0	686	0.00	10.17	0.92	0.90	0.00	0
1995	749	100797	1104	527	577	47.74	13.46	1.47	1.10	0.52	0

5. District : Jaipur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3459	211320	1482	54	1428	3.64	6.11	0.43	0.70	0.03	0
1987	3459	220092	1108	40	1068	3.61	6.36	0.32	0.50	0.02	0
1988	3505	227809	764	68	696	8.90	6.50	0.22	0.34	0.03	0
1989	3505	198024	889	94	795	10.57	5.65	0.25	0.45	0.05	0
1990	3505	231553	785	94	691	11.97	6.61	0.22	0.34	0.04	0
1991	3845	158967	589	34	555	5.77	4.13	0.15	0.37	0.02	0
1992	3886	186737	1166	251	915	21.53	4.81	0.30	0.62	0.13	0
1993	3888	187966	526	63	463	11.98	4.83	0.14	0.28	0.03	0
1994	3888	267882	4408	1733	2675	39.31	6.89	1.13	1.65	0.65	0
1995	3888	326542	8146	1399	6747	17.17	8.40	2.10	2.49	0.43	0

6. District : Jhunjhunu

1985											
1986	1264	67986	1516	43	1473	2.84	5.38	1.20	2.23	0.06	0
1987	1264	50658	1032	13	1019	1.26	4.01	0.82	2.04	0.03	0
1988	1264	65862	666	18	648	2.70	5.21	0.53	1.01	0.03	0
1989	1264	57040	827	28	799	3.39	4.51	0.65	1.45	0.05	0
1990	1264	80775	800	75	725	9.38	6.39	0.63	0.99	0.09	0
1991	1565	73572	674	40	634	5.93	4.70	0.43	0.92	0.05	0
1992	1565	84406	662	128	534	19.34	5.39	0.42	0.78	0.15	0
1993	1582	87278	761	56	705	7.36	5.52	0.48	0.87	0.06	0
1994	1582	130800	3211	896	2315	27.90	8.27	2.03	2.45	0.69	5
1995	1582	149133	6906	390	6516	5.65	9.43	4.37	4.63	0.26	0

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Sikar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1446	95410	300	17	283	5.67	6.60	0.21	0.31	0.02	0
1987	1541	119032	87	0	87	0.00	7.72	0.05	0.07	0.00	0
1988	1541	120482	138	15	123	10.87	7.82	0.09	0.11	0.01	0
1989	1541	101345	127	15	112	11.81	6.58	0.08	0.13	0.01	0
1990	1541	113436	141	12	129	9.30	7.36	0.09	0.12	0.01	0
1991	1837	106479	89	11	78	12.36	5.80	0.05	0.08	0.01	0
1992	1837	116110	82	15	67	18.29	6.32	0.04	0.07	0.01	0
1993	1843	127652	78	8	70	10.25	6.93	0.04	0.06	0.00	0
1994	1843	189046	675	474	201	70.22	10.26	0.37	0.36	0.25	10
1995	1843	198977	638	158	480	24.76	10.80	0.35	0.32	0.08	0

8. District : Sawai Madhopur

1985											
1986	1650	101429	582	60	522	10.31	6.15	0.35	0.57	0.06	0
1987	1650	137760	540	32	508	5.93	8.35	0.33	0.39	0.02	0
1988	1650	138245	817	101	716	12.36	8.38	0.50	0.59	0.07	0
1989	1650	117631	1009	36	973	3.57	7.13	0.61	0.86	0.03	0
1990	1706	219642	3187	1025	2162	32.16	12.87	1.87	1.45	0.47	0
1991	1706	167925	1847	181	1666	9.80	9.84	1.08	1.10	0.11	0
1992	1779	190897	2851	272	2579	9.54	10.73	1.60	1.49	0.14	0
1993	1803	175637	2730	189	2541	6.92	9.74	1.51	1.55	0.11	0
1994	1803	154932	2391	361	2030	15.10	8.59	1.33	1.54	0.23	0
1995(P)	1803	238368	5906	1198	4708	20.28	13.22	3.28	2.48	0.50	8

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : Bikaner

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	840	67837	1277	74	1203	5.79	8.08	1.52	1.88	0.11	0
1987	840	70210	799	16	783	2.00	8.36	0.95	1.14	0.02	0
1988	840	67488	565	28	537	4.96	8.03	0.67	0.84	0.04	0
1989	840	74206	1114	132	982	11.85	8.83	1.33	1.50	0.18	0
1990	840	76015	2043	520	1523	25.45	9.05	2.43	2.69	0.68	0
1991	1209	64729	1120	129	991	11.52	5.35	0.93	1.73	0.20	0
1992	1209	95455	7237	3703	3534	51.17	7.90	5.99	7.58	3.88	0
1993	1211	83980	3675	454	3221	12.35	6.93	3.03	4.38	0.54	0
1994	1211	156034	13329	3640	9689	27.31	12.88	11.01	8.54	2.33	94
1995	1211	180158	13613	924	12689	6.79	14.88	11.24	7.56	0.51	18

10. District: Churu

1985											
1986	1177	80400	1710	37	1673	2.16	6.83	1.45	2.13	0.05	0
1987	1177	73934	577	7	570	1.21	6.28	0.49	0.78	0.01	0
1988	1177	77662	644	33	611	5.12	6.60	0.55	0.83	0.04	0
1989	1177	68766	1097	55	1042	5.01	5.84	0.93	1.60	0.08	0
1990	1177	67632	1556	137	1419	8.80	5.75	1.32	2.30	0.20	0
1991	1539	59922	1211	32	1179	2.64	3.89	0.79	2.02	0.05	0
1992	1539	67675	1483	286	1197	19.29	4.40	0.96	2.19	0.42	0
1993	1543	69980	1707	58	1649	3.39	4.53	1.10	2.43	0.08	0
1994	1543	97483	5900	1522	4378	25.79	6.32	3.82	6.05	1.56	4
1995											

11. District: Sriganganagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1985	191014	4240	286	3954	6.75	9.62	2.14	2.22	0.15	0
1987	1985	191194	1278	32	1246	2.50	9.63	0.64	0.67	0.02	0
1988	1985	170250	238	15	223	6.30	8.58	0.12	0.14	0.01	0
1989	1985	143115	376	15	361	3.99	7.21	0.19	0.26	0.01	0
1990	1985	150175	223	12	211	5.38	7.57	0.11	0.15	0.01	0
1991	2619	158710	218	12	206	5.50	6.06	0.08	0.14	0.01	0
1992	2619	162823	984	291	693	29.57	6.22	0.38	0.60	0.18	0
1993	2623	151977	559	35	524	6.26	5.79	0.21	0.37	0.02	0
1994	1238	100442	640	227	413	35.47	8.11	0.52	0.64	0.23	0
1995	1238	93235	664	87	577	13.10	7.53	0.54	0.71	0.09	0

12. District : Nagaur

1985											
1986	1710	201131	269	4	265	1.49	11.76	0.16	0.13	0.00	0
1987	1710	188456	158	4	154	2.53	11.02	0.09	0.08	0.00	0
1988	1710	202988	308	24	284	7.79	11.87	0.18	0.15	0.01	0
1989	1710	192047	426	36	390	8.45	11.23	0.25	0.22	0.02	0
1990	1710	174332	500	71	429	14.20	10.19	0.29	0.29	0.04	0
1991	2137	197898	360	65	295	18.06	9.26	0.17	0.18	0.03	0
1992	2137	202586	1330	324	1006	24.36	9.48	0.62	0.66	0.16	0
1993	2145	190717	1465	80	1385	5.46	8.89	0.68	0.77	0.04	0
1994	2145	306914	5638	1520	4118	26.96	14.31	2.63	1.84	0.50	2
1995	1593	218448	7190	632	6558	8.79	13.71	4.51	3.29	0.29	0

13. District: Barmer

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1119	77317	566	57	509	10.07	6.91	0.51	0.73	0.07	0
1987	1119	81608	207	34	173	16.43	7.29	0.18	0.25	0.04	0
1988	1119	90345	1710	192	1518	11.23	8.07	1.53	1.89	0.21	0
1989	1119	110781	8133	2303	5830	28.32	9.90	7.27	7.34	2.08	12
1990	1119	159242	19322	6525	12797	33.77	14.23	17.27	12.13	4.10	47
1991	1433	103042	11033	1221	9812	11.07	7.19	7.70	10.71	1.18	4
1992	1433	162375	12210	4182	8028	34.25	11.33	8.52	7.52	2.58	0
1993	1435	133791	5508	836	4672	15.18	9.32	3.84	4.12	0.62	0
1994	1435	382423	39656	20793	18863	52.43	26.65	27.63	10.37	5.44	108
1995	1435	359700	36542	3492	33050	9.56	25.07	25.46	10.16	0.97	7

14. District: Jaisalmer

1985											
1986	231	14300	152	1	151	0.66	6.19	0.66	1.06	0.01	0
1987	231	18321	100	16	84	16.00	7.93	0.43	0.55	0.09	0
1988	241	17907	335	15	320	4.48	7.43	1.39	1.87	0.08	0
1989	241	19608	557	128	429	22.98	8.14	2.31	2.84	0.65	0
1990	241	29647	2007	419	1588	20.88	12.30	8.33	6.77	1.41	0
1991	344	21579	301	79	222	26.25	6.27	0.88	1.39	0.37	0
1992	344	35516	3695	1567	2128	42.41	10.32	10.74	10.40	4.41	0
1993	344	36233	3131	1602	1529	51.17	10.53	9.10	8.64	4.42	0
1994	344	87379	19115	13125	5990	68.66	25.40	55.57	21.88	15.02	56
1995	345	90020	15540	4865	10672	31.33	26.09	45.04	17.26	5.41	15

15. District : Jalore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	906	39960	412	38	374	9.22	4.41	0.45	1.03	0.10	0
1986	906	38043	319	37	282	11.60	4.20	0.35	0.84	0.10	0
1987	906	55080	570	41	529	7.19	6.08	0.63	1.03	0.07	0
1988	906	87889	7131	2298	4833	32.23	9.70	7.87	8.11	2.61	0
1989	906	82117	4979	710	4269	14.26	9.06	5.50	6.06	0.86	0
1990	906	123629	7058	2122	4936	30.07	13.65	7.79	5.71	1.72	0
1991	1142	74632	2409	316	2093	13.12	6.54	2.11	3.23	0.42	0
1992	1142	106672	2103	1009	1094	47.98	9.34	1.84	1.97	0.95	0
1993	1143	36201	1536	465	1071	30.27	3.17	1.34	4.24	1.28	0
1994	1142	160375	5541	2770	2771	49.99	14.04	4.85	3.46	1.73	20
1995	1143	129332	3836	666	3170	17.36	11.32	3.36	2.97	0.51	0

15. District : Jodhpur

1985	1696	128199	1301	317	984		7.56	0.77	1.01	0.25	0
1986	1696	102314	1034	112	922	10.83	6.03	0.61	1.01	0.11	0
1987	1696	100019	399	27	372	6.77	5.90	0.24	0.40	0.03	0
1988	1696	103346	2877	273	2604	9.49	6.09	1.70	2.78	0.26	0
1989	1696	97645	6011	1382	4629	22.99	5.76	3.54	6.16	1.42	0
1990	1696	125399	10462	3000	7462	28.68	7.39	6.17	8.34	2.39	2
1991	2128	110099	6374	1042	5332	16.35	5.17	3.00	5.79	0.95	0
1992	2128	140083	9685	4680	5005	48.32	6.58	4.55	6.91	3.34	0
1993	2153	133403	3096	808	2288	26.10	6.20	1.44	2.32	0.61	0
1994	2153	233772	14919	9580	5339	64.21	10.86	6.93	6.38	4.10	69
1995	2153	194200	8922	2326	6596	26.07	9.02	4.14	4.59	1.20	1

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

17. District: Pali

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1391	122940	1989	265	1724	13.32	8.84	1.43	1.62	0.22	0
1987	1391	146337	3217	466	2751	14.48	10.52	2.31	2.20	0.31	0
1988	1391	194930	10706	2574	8132	24.04	14.01	7.70	5.49	1.32	0
1989	1373	160239	12097	1964	10133	16.24	11.67	8.81	7.55	1.23	0
1990	1391	189542	14678	4036	10642	27.50	13.63	10.55	7.74	2.13	0
1991	1485	134850	9746	1316	8430	13.50	9.08	6.56	7.23	0.98	0
1992	1485	156494	7957	1835	6122	23.06	10.54	5.36	5.08	1.17	0
1993	1486	146679	7339	1100	6239	14.99	9.87	4.94	5.00	0.75	0
1994	1486	199921	12631	3728	8903	29.51	13.45	8.50	6.32	1.86	3
1995	1486	184882	9499	1198	8301	12.61	12.44	6.39	5.14	0.65	0

18. District: Sirohi

1985											
1986	570	35152	268	31	237	11.57	6.17	0.47	0.76	0.09	0
1987	570	55097	648	65	583	10.03	9.67	1.14	1.18	0.12	0
1988	570	76871	4566	1385	3181	30.33	13.49	8.01	5.94	1.80	0
1989	570	66621	7670	1087	6583	14.17	11.69	13.46	11.51	1.63	0
1990	570	81557	5449	1547	3902	28.39	14.31	9.56	6.68	1.90	0
1991	653	48768	3540	600	2940	16.95	7.47	5.42	7.26	1.23	0
1992	653	55778	3214	1303	1911	40.54	8.54	4.92	5.76	2.34	0
1993	654	59260	3609	920	2689	25.49	9.06	5.52	6.09	1.55	0
1994	654	73382	4178	885	3293	21.18	11.22	6.39	5.69	1.21	0
1995	654	61116	2656	367	2289	13.82	9.34	4.06	4.35	0.06	0

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

19. District : Banswara

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	914	136539	6971	4248	2723	60.94	14.94	7.63	5.11	3.11	0
1987	914	131428	6183	3686	2497	59.62	14.38	6.76	4.70	2.80	0
1988	914	118628	4200	2251	1949	53.60	12.98	4.60	3.54	1.90	0
1989	914	754292	2315	1155	1160	49.89	8.25	2.53	0.30	1.53	0
1990	914	112117	2381	1158	1223	48.64	12.27	2.61	2.12	1.03	0
1991	1155	121594	3085	1594	1491	51.67	10.53	2.67	2.54	1.31	0
1992	1155	156340	3026	1342	1684	44.35	13.54	2.62	1.94	0.86	0
1993	1156	154151	3884	2130	1754	54.84	13.33	3.36	2.52	1.38	0
1994	1156	150869	3007	1457	1550	48.45	13.05	2.60	1.99	0.97	0
1995	1156	156088	1799	839	960	46.64	13.50	1.56	1.15	0.54	0

20. District: Bhilwara

1985											
1986	1309	195551	3268	801	2467	24.51	14.94	2.50	1.67	0.41	0
1987	1309	186390	14146	530	3616	12.79	14.24	3.17	2.22	0.28	0
1988	1308	191738	6114	1237	4877	20.23	14.66	4.67	3.19	0.65	0
1989	1308	155238	7450	1183	6267	15.88	11.87	5.70	4.80	0.76	0
1990	1309	183151	6140	1075	5065	17.51	13.99	4.69	3.35	0.59	0
1991	1591	172993	5116	936	4180	18.30	10.87	3.22	2.96	0.54	0
1992	1591	203815	10046	2061	7985	20.52	12.81	6.31	4.93	1.01	0
1993	1593	212636	10800	2062	8738	19.09	13.35	6.78	5.08	0.97	0
1994	1593	253156	26547	7066	19481	26.62	15.89	16.66	10.49	2.79	30
1995	2145	288668	25210	3974	21236	15.76	13.46	11.75	8.73	1.38	9

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

21. District : Chittorgarh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1236	126520	4059	774	3285	19.07	10.24	3.28	3.21	0.61	0
1987	1236	165333	8263	1460	6803	17.67	13.38	6.69	5.00	0.88	0
1988	1236	182693	15535	4649	10886	29.92	14.78	12.57	8.50	2.54	0
1989	1236	157623	13677	2328	11349	17.02	12.75	11.07	8.68	1.48	0
1990	1236	152337	5838	2180	3658	37.34	12.33	4,72	3.83	1.43	0
1991	1482	124921	4696	1144	3552	24.36	8.43	3.17	3.76	0.92	0
1992	1482	138383	4864	837	4027	17.21	9.34	3.28	3.51	0.60	0
1993	1484	142128	4362	899	3463	20.61	9.58	2.94	3.07	0.63	0
1994	1484	153939	5801	1339	4462	23.08	10.37	3.91	3.77	0.87	0
1995	1484	138164	5500	450	5050	8.18	9.31	3.71	3.98	0.33	0

22. District: Dungarpur

1985											
1986	683	87688	2799	1664	1135	59.45	12.84	4.10	3.19	1.90	0
1987	683	82031	7191	2662	4529	37.02	12.01	10.53	8.77	3.25	0
1988	683	83451	8041	5147	2894	64.01	12.22	11.77	9.64	6.17	0
1989	683	59362	7085	4202	2883	59.31	8.69	10.37	11.94	7.08	0
1990	683	73187	5357	2863	2494	53.44	10.72	7.84	7.31	3.91	0
1991	874	70249	4099	1971	2128	48.08	8.04	4.69	5.83	2.81	0
1992	874	72374	6050	3923	2127	64.84	8.28	6.92	8.36	5.42	0
1993	874	84158	7605	4223	3382	55.53	9.62	8.70	9.04	5.02	0
1994	874	98901	7988	4321	3667	54.09	11.32	9.14	8.08	4.37	1
1995	875	109766	7925	2492	5433	31.44	12.54	9.06	7.22	2.27	0

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

23. District: Udaipur

Year	Pop. (IN 000'S)	BSE	Positive	Pf	Pv Mixed	Pf %	ABER	API	SPR	SfR	Deaths
1985											
1986	2357	246143	7109	1934	5175	27.20	10.44	3.02	2.89	0.79	0
1987	2357	349336	15886	2307	13579	14.52	14.82	6.74	4.55	0.66	0
1988	2357	336613	18146	4182	13964	23.05	14.28	7.70	5.39	1.24	0
1989	2775	277834	18528	4231	14297	22.84	10.01	6.68	6.67	1.52	0
1990	2775	318180	12580	2609	9971	20.74	11.47	4.53	3.95	0.82	0
1991	2034	174679	6105	2181	3924	35.72	8.59	3.00	3.49	1.25	0
1992	2064	194482	9700	3743	5957	38.59	9.42	4.69	4.99	1.92	0
1993	2094	211019	13040	4184	8856	32.09	10.08	6.23	6.18	1.98	0
1994	2094	221193	15640	5406	10234	34.57	10.56	7.47	7.07	2.44	0
1995	2094	194433	10791	2259	8532	20.93	9.29	5.15	5.55	1.16	0

24. District : Bundi

1985											
1986	608	44199	1099	397	702	36.12	7.27	1.81	2.49	0.90	0
1987	608	40396	727	76	651	10.45	6.64	1.20	1.80	0.19	0
1988	608	55024	766	102	664	13.32	9.05	1.26	1.39	0.19	0
1989	608	67257	958	153	805	15.97	11.06	1.58	1.42	0.23	0
1990	608	57692	1040	271	769	26.06	9.49	1.71	1.80	0.47	0
1991	768	58826	1363	688	675	50.48	7.66	1.77	2.32	1.17	0
1992	768	67006	3244	1343	1901	41.40	8.72	4.22	4.84	2.00	0
1993	770	53438	2398	563	1835	23.48	6.94	3.11	4.49	1.05	0
1994	770	72354	2965	1042	1923	35.14	9.40	3.85	4.10	1.44	1
1995	770	75001	3774	495	3279	13.12	9.74	4.90	5.03	0.66	0

25. District: Jhalawar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	832	113939	1796	766	1030	42.65	13.69	2.16	1.58	0.67	0
1987	832	106996	2395	986	1409	41.17	12.86	2.88	2.24	0.92	0
1988	832	122823	2454	1171	1283	47.72	14.76	2.95	2.00	0.95	0
1989	832	106141	1266	519	747	41.00	12.76	1.52	1.19	0.49	1
1990	832	106190	815	306	509	37.55	12.76	0.98	0.77	0.29	1
1991	956	99739	648	201	447	31.02	10.43	0.68	0.65	0.20	4
1992	956	113808	471	210	261	44.59	11.90	0.49	0.41	0.18	0
1993	957	105667	1317	521	796	39.56	11.04	1.38	1.25	0.49	0
1994	957	111097	1614	709	905	43.93	11.61	1.69	1.45	0.64	0
1995	957	81345	768	236	532	30.73	8.50	0.80	0.94	0.29	0

26. District: Kota

1985											
1986	1648	171305	2968	1061	1907	35.75	10.39	1.80	1.73	0.62	0
1987	1673	189736	4534	1049	3485	23.14	11.34	2.71	2.39	0.55	0
1988	1697	206441	6103	1996	4107	32.71	12.17	3.60	2.96	0.97	0
1989	1706	181630	5076	1387	3689	27.32	10.65	2.98	2.79	0.76	0
1990	1706	219642	3187	1025	2162	47.40	12.87	1.86	1.45	0.46	0
1991	1213	112154	1674	832	842	49.70	9.25	1.38	1.49	0.74	0
1992	1213	125960	2554	1151	1403	45.07	10.38	2.11	2.03	0.91	0
1993	1221	118817	3656	1565	2091	42.81	9.73	2.99	3.08	1.32	0
1994	1220	126885	5290	1880	3410	35.54	10.40	4.34	4.17	1.48	0
1995	1221	144994	5482	1333	4149	24.32	11.88	4.49	3.78	0.92	0

RAJASTHAN - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

27. District : Tonk

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	784	68431	566	77	489	13.60	8.73	0.72	0.83	0.11	0
1987	784	90052	491	40	451	8.15	11.49	0.63	0.55	0.04	0
1988	784	94977	979	132	847	13.48	12.11	1.25	1.03	0.14	0
1989	784	95024	1145	175	970	15.28	12.12	1.46	1.20	0.18	0
1990	784	106895	1284	307	977	23.91	13.63	1.64	1.20	0.29	0
1991	973	97313	1013	224	789	22.11	10.00	1.04	1.04	0.23	0
1992	973	110217	3298	1240	2058	37.60	11.33	3.39	2.99	1.13	0
1993	975	97690	2654	375	2279	14.13	10.02	2.72	2.72	0.38	0
1994	975	97703	4612	1748	2864	37.90	10.02	4.73	4.72	1.79	0
1995	975	129286	6893	1216	5677	17.64	13.26	7.07	5.33	0.94	0

28. District: Dausa

1985		New Distt. created from jaipur in 1991									
1986											
1987											
1988											
1989											
1990											
1991	874	46101	172	22	150	12.79	5.27	0.20	0.37	0.05	0
1992	1008	84256	867	113	754	13.03	8.36	0.86	1.03	0.13	0
1993	994	76279	420	124	296	29.52	7.67	0.42	0.55	0.16	0
1994	994	85250	297	72	225	24.24	8.58	0.30	0.35	0.08	0
1995	994	109032	2783	391	2392	14.05	10.97	2.80	2.55	0.36	0

29. District : Baran

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created from Sirihi in 1991										
1986											
1987											
1988											
1989											
1990											
1991	814	76332	905	298	607	32.93	9.38	1.11	1.19	0.39	0
1992	814	89666	1091	346	745	31.71	11.02	1.34	1.22	0.39	0
1993	810	101252	1824	662	1162	36.29	12.50	2.25	1.80	0.65	0
1994	810	118187	3621	1903	1718	52.55	14.59	4.47	3.06	1.61	26
1995	810	133895	3600	859	2741	23.86	16.53	4.44	2.69	0.64	1

30. Hanumangarh

	Created in 1994										
1994	1385	89067	5035	290	4745	5.75	6.43	3.63	5.65	0.32	0

31. Rajsamand

	Created in 1994										
1994	796	97590	2823	499	2324	17.67	12.26	3.54	2.89	0.51	0

SIKKIM - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : East District

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	94	11934	15	1	14	6.67	12.70	0.16	0.13	0.01	0
1987	98	11816	8	0	8	0.00	12.06	0.08	0.07	0.00	0
1988	98	11809	9	1	8	11.11	12.05	0.09	0.08	0.01	0
1989	100	10788	20	3	17	15.00	10.79	0.20	0.19	0.03	0
1990	102	10043	7	0	7	0.00	9.85	0.07	0.07	0.00	0
1991	106	10203	13	1	12	7.69	9.63	0.12	0.13	0.01	0
1992	108	12712	189	147	42	77.78	11.77	1.75	1.49	1.16	0
1993	117	9977	58	35	23	60.34	8.53	0.50	0.58	0.35	0
1994	117	7679	39	7	32	17.95	6.56	0.33	0.51	0.09	0
1995	52	9496	57	3	54	5.26	18.26	1.10	0.60	0.03	0

2. District : West District

1985											
1986	43	6324	8	0	8	0.00	14.71	0.19	0.13	0.00	0
1987	44	5899	3	0	3	0.00	13.41	0.07	0.05	0.00	0
1988	45	6478	5	0	5	0.00	14.40	0.11	0.08	0.00	0
1989	46	5488	2	0	2	0.00	11.93	0.04	0.04	0.00	0
1990	46	5379	0	0	0	0.00	11.69	0.00	0.00	0.00	0
1991	48	4796	0	0	0	0.00	9.99	0.00	0.00	0.00	0
1992	53	4554	1	0	1	0.00	8.59	0.02	0.02	0.00	0
1993	52	3104	1	0	1	0.00	5.97	0.02	0.03	0.00	0
1994	27	2551	2	0	2	0.00	4.91	0.04	0.08	0.00	0
1995	24	2578	7	0	7	0.00	1.74	0.29	0.27	0.00	0

SIKKIM - Districtwise & yearwise Epidemiological Data & Parameters (1985-1995)

3. District : North District

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	17	2403	9	1	8	11.11	14.14	0.53	0.37	0.04	0
1987	16	2040	4	0	4	0.00	12.75	0.25	0.20	0.00	0
1988	16	2655	6	0	6	0.00	16.59	0.38	0.23	0.00	0
1989	17	2273	3	0	3	0.00	13.37	0.18	0.13	0.00	0
1990	17	2325	4	0	4	0.00	13.68	0.24	0.17	0.00	0
1991	17	2010	3	0	3	0.00	11.82	0.18	0.15	0.00	0
1992	19	1648	1	0	1	0.00	8.67	0.05	0.06	0.00	0
1993	18	1263	1	1	0	100.00	7.02	0.06	0.08	0.08	0
1994	18	906	1	0	1	0.00	5.03	0.06	0.11	0.00	0
1995	55	579	0	0	0	0.00	1.05	0.00	0.00	0.00	0

4. District : South District

1985											
1986	59	8410	13	1	12	7.69	14.25	0.22	0.15	0.01	0
1987	62	8529	9	0	9	0.00	13.76	0.15	0.11	0.00	0
1988	60	7999	3	1	2	33.33	13.33	0.05	0.04	0.01	0
1989	63	7356	5	2	3	40.00	11.68	0.08	0.07	0.03	0
1990	60	7180	6	4	2	66.67	11.97	0.10	0.08	0.06	0
1991	65	9900	30	3	27	10.00	15.23	0.46	0.30	0.03	0
1992	65	9391	17	2	15	11.76	14.45	0.26	0.18	0.02	0
1993	72	6572	8	0	8	0.00	9.13	0.11	0.12	0.00	0
1994	72	5439	16	1	15	6.25	7.55	0.22	0.29	0.02	0
1995	45	8444	150	1	179	0.67	18.76	3.33	1.78	0.01	0

*(P)

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Madras

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3753	557125	39197	2603	36594	6.64	14.84	10.44	7.04	0.47	0
1987	3829	600488	31179	2198	28941	7.05	15.68	8.14	5.19	0.37	0
1988	3932	568634	34400	1982	32418	5.76	14.46	8.74	6.04	0.34	0
1989	4056	605660	45622	2542	43080	5.57	14.93	11.24	7.53	0.41	0
1990	4077	602164	51272	3921	47351	7.64	14.76	12.57	8.51	0.65	0
1991	3815	596597	67013	8024	58989	11.97	15.63	17.56	11.23	1.34	0
1992	3875	611166	72314	7846	64468	10.85	15.77	18.66	11.83	1.28	0
1993	3994	448230	76749	5877	70872	7.66	11.22	19.22	17.12	1.31	0
1994	4063	371581	48352	2057	46295	4.25	9.15	11.90	13.01	0.55	0
1995(P)	4148	334960	38445	828	37617	2.15	8.07	9.27	11.48	0.25	0

2. District : Kancheepuram (Chengai-MGR Division)

1985											
1986											
1987											
1988	2036	113683	814	18	796	2.21	5.58	0.40	0.72	0.02	0
1989	2017	84391	505	11	494	2.18	4.18	0.25	0.60	0.01	0
1990	2027	146586	279	5	274	1.79	7.23	0.14	0.19	0.00	0
1991	2027	154068	455	7	448	1.53	7.60	0.22	0.29	0.00	0
1992	2027	146878	400	15	385	3.75	7.24	0.19	0.27	0.01	0
1993	2184	184528	565	13	552	2.30	8.45	0.26	0.31	0.01	0
1994	2244	179367	386	7	379	1.81	7.99	0.17	0.22	0.00	0
1995(P)											

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : Saidapet (Chengai-MGR Distt.)/HUD

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	For the distt as a whole N.B. Information from 1988 onwards is for HUD instead of Reserve distt.										
1987											
1988	2363	175007	399	11	388	2.76	7.41	0.17	0.23	0.01	0
1989	2380	143910	1112	13	1099	1.17	6.05	0.47	0.77	0.01	0
1990	2380	205709	3036	33	3003	1.09	8.64	1.28	1.48	0.02	0
1991	2620	161376	818	9	809	1.10	6.15	0.03	0.50	0.00	0
1992	2693	203865	1308	20	1288	1.52	7.57	0.00	0.64	0.00	0
1993	2796	269398	3594	37	3557	1.03	9.64	1.29	1.33	0.01	0
1994	2886	289606	4800	37	4763	0.77	10.03	1.66	1.66	0.01	0
1995(P)											

4. District : Vellore (North-Arcot Ambedkar Division.)

1985											
1986											
1987											
1988	N. B. Information from 1988 onwards is for HUD instead of Revenue distt.										
1989											
1990											
1991	1543	265636	704	107	597	15.19	17.21	0.04	0.26	0.04	0
1992	1556	265726	868	108	760	12.44	17.07	0.05	0.32	0.04	0
1993	1605	325329	1944	108	1836	5.56	20.27	1.21	0.60	0.03	0
1994	1629	257297	2031	92	1939	4.53	15.79	1.25	0.79	0.04	6
1995(P)											

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : (Tirupattur) Vellore North Arcot Ambedkar Division

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	N.B. Information for Blank years for HUDS is included in their respective reserve districts										
1986											
1987											
1988											
1989											
1990											
1991	1394	108324	572	10	562	1.74	7.76	0.04	0.52	0.00	0
1992	1416	113061	824	10	814	1.21	7.98	0.05	0.72	0.00	0
1993	1530	157533	647	3	644	0.46	10.30	0.42	0.41	0.00	0
1994	1554	147338	1030	261	769	25.34	9.48	0.66	0.70	0.18	0
1995(P)											

6. District : Tiruvanamalai Sambuvarayar. Distt.

1985											
1986											
1987											
1988	995	157788	176	19	157	10.79	15.85	0.17	0.11	0.01	0
1989	1014	126798	208	29	179	13.94	12.50	0.20	0.16	0.02	0
1990	1020	169472	975	81	894	8.30	16.61	0.95	0.57	0.04	0
1991	1147	173378	2353	216	2137	9.17	15.12	0.20	1.35	0.12	0
1992	1147	276658	4962	646	4316	13.02	24.12	4.32	1.79	0.23	0
1993	1231	194593	4747	565	4182	11.90	15.81	3.86	2.44	0.29	0
1994	1249	184635	1665	116	1549	6.97	14.78	1.33	0.90	0.06	0
1995(P)	2736	273600	1452	206	1246		14.19	0.53	0.08	0.08	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Cheyya (Thiruvannamalai- Sambuvarayar. Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988	1775	155565	135	7	128	5.18	8.76	0.07	0.08	0.00	0
1989	1026	109527	218	15	203	6.88	10.67	0.21	0.19	0.01	0
1990	1836	156138	316	36	280	11.39	8.50	0.17	0.20	0.02	0
1991	734	61399	112	12	100	10.71	8.36	0.01	0.18	0.01	0
1992	734	81354	169	24	145	14.20	11.07	0.02	0.20	0.02	0
1993	882	89446	284	15	269	5.28	10.14	0.32	0.32	0.02	0
1994	894	100552	164	11	153	6.71	11.25	0.18	0.16	0.01	0
1995(P)											

8. District : Cuddalore (South Arcot-Vallalar Division.)

1985											
1986											
1987											
1988	1663	107382	128	4	124	3.12	6.45	0.07	0.11	0.00	0
1989	1672	84404	149	3	146	2.01	5.04	0.08	0.17	0.00	0
1990	1680	104941	159	8	151	5.03	6.24	0.09	0.15	0.00	0
1991	2119										
1992	2164	203975	360	26	334	7.22	9.42	0.01	0.17	0.01	0
1993	2203	258427	271	11	260	4.06	11.73	0.12	0.10	0.00	0
1994	2238	282410	292	10	282	3.42	12.62	0.13	0.10	0.00	0
1995(P)	2921	250058	1060	68	992	6.42	8.56	0.36	0.42	0.03	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

9. District : Villupuram (Villupuram Ramasamy Padayatchiar Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988	1569	175577	279	2	277	0.71	11.19	0.17	0.15	0.00	0
1989	1576	129609	171	2	169	1.16	8.22	0.10	0.13	0.00	0
1990	1584	164585	241	3	238	1.24	10.39	0.15	0.14	0.00	0
1991											
1992											
1993	2861	336302	2626	263	2363	10.02	11.75	0.92	0.78	0.08	0
1994	2861	201424	676	17	659	2.51	7.04	0.23	0.34	0.01	0
1995(P)	2921	250058	1060	68	992	6.42	8.56	0.36	0.42	0.03	0

10. Distt. : Thanjayur

1985											
1986	4380	595031	277	12	265	4.33	13.59	0.06	0.05	0.00	0
1987	4380	533681	589	42	547	7.13	12.18	0.13	0.11	0.01	0
1988	2122	140266	29	4	25	13.79	6.61	0.01	0.02	0.00	0
1989	2142	119020	31	3	28	9.67	5.55	0.01	0.02	0.00	0
1990	2153	128187	29	2	27	6.89	5.95	0.01	0.02	0.00	0
1991	2235	144938	33	3	30	9.09	6.48	0.00	0.02	0.00	0
1992	2389	195437	71	7	64	9.86	8.18	0.03	0.04	0.00	0
1993	2389	223975	36	5	31	13.89	9.37	0.01	0.02	0.00	0
1994	2389	214111	43	2	41	4.65	8.96	0.01	0.02	0.00	0
1995(P)	2439	159958	38	2	36	5.26	6.56	0.02	0.02	0.00	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Thiruvarur (Nagapattinam Quid-e-Millajh Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988	2376	203164	778	15	763	1.92	8.55	0.32	0.38	0.00	0
1989	2416	121790	1672	131	1541	7.83	5.04	0.69	1.37	0.10	0
1990	2428	125748	2424	778	1646	32.09	5.17	0.99	1.92	0.61	0
1991	1998	120512	2031	284	1747	13.98	6.03	0.10	1.68	0.23	0
1992	2021	139531	508	12	496	2.36	6.90	0.02	0.36	0.00	0
1993	2513	147470	510	10	500	1.96	5.87	0.20	0.35	0.01	0
1994	2513	103219	195	2	193	1.03	4.10	0.07	0.19	0.00	0
1995(P)											

12. District : Tiruchirapalli

1985											
1986	3870	448143	327	13	314	3.98	11.58	0.08	0.07	0.00	0
1987	4481	457370	252	18	234	7.14	10.21	0.06	0.06	0.00	0
1988	2301	202042	315	10	305	3.17	8.78	0.13	0.15	0.00	0
1989	2326	130769	307	14	293	4.56	5.62	0.13	0.23	0.01	0
1990	2338	146375	266	19	247	7.14	6.26	0.11	0.18	0.01	0
1991											
1992	4191	261215	478	15	463	3.14	6.23	0.11	0.18	0.01	0
1993	2538	158384	417	12	405	2.87	6.24	0.16	0.26	0.00	0
1994	2564	143574	369	5	364	1.36	5.60	0.14	0.26	0.00	0
1995(P)	2617	236080	341	7	334	2.05	9.02	0.13	0.14	0.00	0

TAMILNADU- Districtwise & yearwise Epidemiological Data & Parameters (1985-1995)

13. District : Karur (Thiruchirapally Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988	1662	75955	22	1	21	4.54	4.57	0.01	0.02	0.00	0
1989	1605	59206	86	1	85	1.16	3.68	0.05	0.14	0.00	0
1990	1993	127107	50	0	50	6.00	6.37	0.02	0.03	0.00	0
1991	1437										
1992	1673	102256	209	1	208	0.47	6.11	0.01	0.20	0.00	0
1993	1753	108367	225	1	224	0.44	6.18	0.13	0.21	0.00	0
1994	1779	92031	109	1	108	0.92	5.17	0.06	0.12	0.00	0
1995(P)											

14. District : Pudukottai (HUD)

1985											
1986	1290	185978	93	3	90	3.23	14.42	0.07	0.05	0.00	0
1987	1290	183089	68	5	63	7.35	14.19	0.05	0.04	0.00	0
1988	1346	103254	140	3	137	2.14	7.67	0.10	0.13	0.00	0
1989	1300	79806	167	3	164	1.79	6.13	0.12	0.20	0.00	0
1990	1387	140491	171	7	164	1.79	10.12	0.12	0.12	0.00	0
1991	704	67159	62	0	62	0.00	9.54	0.00	0.09	0.00	0
1992	1348	124687	292	3	289	1.03	9.25	0.22	0.23	0.00	0
1993	729	75636	62	2	60	3.23	10.38	0.09	0.08	0.00	0
1994	739	80658	53	1	52	1.89	10.91	0.07	0.07	0.00	0
1995(P)	754	109001	243	0	243	0.00	14.46	0.32	0.22	0.00	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

15. District : Aranthangi (Pudukotti Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	622	48781	314	0	314	0.00	7.84	0.05	0.64	0.00	0
1992	635	43039	229	0	229	0.00	6.77	0.03	0.53	0.00	0
1993	644	45643	282	0	282	0.00	7.09	6.44	0.61	0.00	0
1994	654	49054	123	0	123	0.00	7.50	0.19	0.25	0.00	0
1995(P)											

16. District : Madurai (Maduri Division)

1985											
1986	2160	221969	324	8	316	2.47	10.28	0.15	0.15	0.00	0
1987	2160	238438	274	8	266	2.92	11.04	0.13	0.11	0.00	0
1988	1973	185610	484	5	399	1.23	9.40	0.20	0.21	0.00	0
1989	2029	98596	87	5	82	5.74	4.85	0.04	0.08	0.00	0
1990	2040	95337	101	5	96	4.95	4.67	0.04	0.10	0.00	0
1991	2135	105671	89	3	86	3.37	4.94	0.04	0.08	0.00	0
1992	3522	225011	324	9	315	2.78	6.39	0.09	0.14	0.00	0
1993	2202	171439	194	3	191	1.55	7.79	0.09	0.11	0.00	0
1994	2238	200596	121	3	118	2.48	8.96	0.05	0.06	0.00	0
1995(P)	2284	298704	155	13	142	8.39	13.08	0.07	0.05	0.00	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

17. District : Periyakulam (Mudurai Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1380	121656	31	0	31	0.00	8.82	0.02	0.03	0.00	0
1987	1380	134824	46	1	45	2.17	9.77	0.03	0.03	0.00	0
1988	1331	109834	30	3	27	10.00	8.25	0.02	0.02	0.00	0
1989	1353	72332	36	0	36	0.00	5.34	0.02	0.04	0.00	0
1990	1360	85902	56	4	52	7.14	6.31	0.04	0.06	0.00	0
1991	1330	80638	50	8	42	16.00	6.06	0.00	0.06	0.00	0
1992	1352	91912	178	6	172	3.37	6.80	0.01	0.19	0.00	0
1993	1378	114065	57	0	57	0.00	8.28	0.04	0.04	0.00	0
1994	1401	112388	16	0	16	0.00	8.02	0.01	0.01	0.00	0
1995(P)											

18. District : Dindigul (Dindugal-anna Division.)

1985											
1986	1360	218914	303	4	299	1.32	16.10	0.22	0.14	0.00	0
1987	1654	208789	400	8	392	2.00	12.62	0.24	0.19	0.00	0
1988	1740	197207	459	6	453	1.30	11.33	0.26	0.23	0.00	0
1989	1765	106242	629	4	625	0.63	6.01	0.35	0.59	0.00	0
1990	1774	107484	2428	6	2422	0.24	6.05	1.36	2.25	0.00	0
1991	981	77971	4765	0	4765	0.00	7.95	0.48	6.11	0.00	0
1992	1800	174460	9628	19	9609	0.20	9.69	5.35	5.52	0.01	0
1993	1071	115878	10548	3	10545	0.03	10.82	9.85	9.10	0.00	0
1994	1030	103557	6809	10	6799	0.15	10.05	6.61	6.58	0.01	0
1995(P)	1051	141776	1980	3	1977	0.15	13.49	1.88	1.40	0.00	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

19. District : Palani (Dindugal-Anna Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	583	35297	36	1	35	2.77	6.05	0.00	0.10	0.00	0
1992	623	47613	47	7	40	14.89	7.63	0.00	0.09	0.01	0
1993	795	53094	44	0	44	0.00	6.68	0.06	0.08	0.00	0
1994	806	42875	41	3	38	7.32	5.32	0.05	0.10	0.01	0
1995(P)											

20. District : Ramanathapuram (Ramanathapuram Division)

1985											
1986	1120	239044	3895	115	3780	2.95	21.34	3.47	1.62	0.04	0
1987	1120	240708	4593	241	4352	5.25	21.49	4.10	1.91	0.10	0
1988	1158	210824	16270	1695	14575	10.41	18.20	14.05	7.71	0.80	0
1989	1176	120245	11484	477	11007	4.15	10.22	9.76	9.55	0.39	0
1990	1182	143212	19318	751	18567	3.88	12.11	16.34	13.48	0.52	0
1991	562	185801	31977	1667	30310	5.21	33.04	5.68	17.21	0.29	0
1992	1153	211950	20638	902	19736	4.37	18.38	17.90	9.74	0.43	0
1993	599	160004	12825	716	12109	5.58	26.71	21.41	8.02	0.44	0
1994	606	172749	14122	1034	13088	7.32	28.51	23.30	8.17	0.60	0
1995(P)	618	240688	16245	1343	14902	8.27	38.95	26.29	6.75	0.56	0

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

21. District : Paramakudi Division (Ramanathapuram Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	599	49665	1143	23	1120	2.01	8.28	0.19	2.30	0.04	0
1992	610	66573	980	18	962	1.83	10.91	0.16	1.47	0.02	0
1993	610	97134	1552	16	1536	1.03	15.92	2.54	1.60	0.02	0
1994	610	95795	1135	174	961	15.33	15.70	1.86	1.18	0.18	0
1995(P)											

22. District : Sivaganga (Pasumpom Muthuramalingam Distt.)

1985											
1986	1050	141047	137	5	132	3.65	13.43	0.13	0.10	0.00	0
1987	1050	134239	144	7	137	4.86	12.78	0.14	0.11	0.01	0
1988											
1989											
1990											
1991	479	32424	322	9	313	2.79	6.76	0.06	0.99	0.02	0
1992	488	36300	266	17	249	6.39	7.44	0.05	0.73	0.04	0
1993	571	55105	105	8	97	7.62	9.65	0.18	0.19	0.01	0
1994	578	66157	158	4	154	2.53	11.45	0.27	0.24	0.01	0
1995(P)											

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

23. District : Devakottai (Pasumpon Muthura Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	434	21790	98	3	95	3.06	5.02	0.02	0.44	0.01	0
1992	443	18167	45	3	42	6.66	4.10	0.01	0.24	0.01	0
1993	537	33837	49	7	42	14.29	6.30	0.09	0.14	0.02	0
1994	543	39295	24	0	24	0.00	7.24	0.04	0.06	0.00	0
1995(P)					.						

24. District : Virudhunagar (Kamarajar Division.)

1985											
1986	1460	122382	40	3	37	7.50	8.38	0.03	0.03	0.00	0
1987	1460	144197	46	8	38	17.39	9.88	0.03	0.03	0.01	0
1988											
1989											
1990											
1991	335	30074	50	0	50	0.00	8.98	0.01	0.16	0.00	0
1992	429	56990	21	0	21	0.00	13.29	0.00	0.03	0.00	0
1993	641	72433	28	4	24	14.29	11.30	0.04	0.04	0.01	0
1994	652	62068	33	1	32	3.03	9.52	0.05	0.05	0.00	0
1995(P)											

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

25. District : Sivakasi (Kamarajar Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	702	39496	12	0	12	0.00	5.62	0.00	0.03	0.00	0
1992	713	92218	41	3	38	7.31	12.93	0.00	0.04	0.00	0
1993	986	91162	19	0	19	0.00	9.25	0.02	0.02	0.00	0
1994	1003	82641	11	0	11	0.00	8.24	0.01	0.01	0.00	0
1995(P)											

26. District : Tirunelveli (Thirunelvelil - Kattabomman Division.)

1985											
1986	3800	458431	720	17	703	2.36	12.06	0.19	0.16	0.00	0
1987	3858	571394	1100	19	1081	1.73	14.81	0.29	0.19	0.00	0
1988	2415	290058	201	18	188	8.95	12.01	0.08	0.06	0.00	0
1989	2443	192521	502	9	493	1.79	7.88	0.20	0.26	0.00	0
1990	2455	278078	457	18	439	3.93	11.32	0.18	0.16	0.00	0
1991	1467	140563	319	3	316	0.94	9.58	0.02	0.22	0.00	0
1992	2534	324073	817	14	. 803	1.71	12.79	0.32	0.25	0.00	0
1993	1442	168207	709	7	702	0.99	11.66	0.49	0.42	0.00	0
1994	1459	170657	327	13	314	3.98	11.70	0.22	0.19	0.01	0
1995(P)											

TAMILNADU- Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

27. District : Sankarankoil (Thirunelvelil - Kattabomman Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	1101	139874	117	19	98	16.23	12.69	0.01	0.08	0.01	0
1992	1112	147574	203	6	197	2.95	13.26	0.01	0.13	0.00	0
1993	1134	189569	496	26	470	5.24	16.72	0.44	0.26	0.01	0
1994	1149	194219	723	8	715	1.11	16.90	0.63	0.37	0.00	1
1995(P)											

28. District : Tuticorin (V.O. Chidambaranar Division.)

1985											
1986											
1987											
1988											
1989											
1990											
1991	902	19347	1103	8	1095	0.72	2.14	0.12	5.70	0.04	0
1992	909	167704	14547	78	14469	0.53	18.45	1.60	8.67	0.04	0
1993	911	192006	14317	281	14036	1.96	21.08	15.72	7.46	0.15	0
1994	917	179805	7678	190	7488	2.47	19.61	8.37	4.27	0.11	0
1995											

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

29. District : Kovelipatti (V.O.Chidambaranar Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	557	52617	283	3	280	1.06	9.44	0.05	0.53	0.00	0
1992	565	61283	97	2	95	2.06	10.84	0.01	0.15	0.00	0
1993	572	73769	611	2	609	0.33	12.90	1.07	0.83	0.00	0
1994	578	83015	481	2	479	0.42	14.36	0.83	0.58	0.00	0
1995(P)											

30. District : Nagarcoil (Kanyakumari Division.)

1985											
1986	1550	189749	33	1	32	3.03	12.24	0.02	0.02	0.00	0
1987	1550	226948	28	2	26	7.14	14.64	0.02	0.01	0.00	0
1988											
1989											
1990											
1991	520	40220	85	7	78	8.23	7.74	0.01	0.21	0.01	0
1992	527	44590	138	49	89	35.50	8.45	0.02	0.30	0.10	0
1993	1647	159895	674	18	656	2.67	9.71	0.41	0.42	0.01	0
1994	1668	162738	929	40	889	4.31	9.76	0.56	0.57	0.02	0
1995(P)											

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

31. District : Padmanbhapuram Divison (Kanyakumari Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	1015	98458	164	0	164	0.00	9.70	0.01	0.16	0.00	0
1992	1061	104829	72	0	72	0.00	9.88	0.00	0.06	0.00	0
1993	1077	110945	114	0	114	0.00	10.30	0.01	0.10	0.00	0
1994											
1995(P)											

32. District: Salem (Salem Divison)

1985											
1986	3677	409506	6766	310	6456	4.58	11.14	1.84	1.65	0.08	0
1987	3789	404824	7405	323	7082	4.36	10.68	1.95	1.83	0.08	0
1988	1502	113231	2640	81	2559	3.06	7.53	1.75	2.33	0.07	0
1989	1512	108730	2853	75	2778	2.62	7.19	1.88	2.62	0.06	0
1990	1520	103852	2094	61	2033	2.91	6.83	1.37	2.01	0.05	0
1991	2037	186940	2745	330	2415	12.02	9.17	0.13	1.46	0.17	0
1992	3986	500117	8296	828	7468	9.98	12.55	2.08	1.66	0.17	0
1993	2278	213346	1498	288	1210	19.23	9.37	0.66	0.70	0.13	0
1994	2306	322802	932	166	766	17.81	14.00	0.40	0.29	0.05	0
1995(P)	2354	499327	2635	234	2401	8.88	21.21	1.12	0.53	0.05	0

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

33. District : Namakkal (Salem Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988	872	95037	660	14	646	2.12	10.89	0.75	0.69	0.01	0
1989	892	99027	525	13	512	2.47	11.10	0.58	0.53	0.01	0
1990	896	123822	1139	32	1107	2.80	13.81	1.27	0.91	0.02	0
1991	1721	248412	3891	555	3336	14.26	14.43	0.22	1.56	0.22	0
1992	1758	289540	5102	437	4665	8.56	16.46	0.29	1.76	0.15	0
1993	1742	277182	4057	199	3858	4.91	15.91	2.33	1.46	0.07	0
1994	1768	241783	2642	116	2526	4.39	13.68	1.49	1.09	0.05	0
1995(P)											

34. District : Dharmapuri (Dharmapuri Division)

1985											
1986	2200	293824	546	70	476	12.82	13.36	0.25	0.19	0.02	0
1987	2330	271418	399	55	344	13.78	11.65	0.17	0.15	0.02	0
1988	2278	197533	466	68	398	14.59	8.67	0.20	0.23	0.03	0
1989	2322	151095	517	74	448	14.31	6.50	0.22	0.34	0.04	0
1990	2334	227597	1524	171	1353	11.22	9.75	0.65	0.66	0.07	0
1991	1119	141689	1158	147	1011	12.69	12.65	0.10	0.81	0.10	0
1992	2460	399654	4651	832	3819	17.89	16.25	1.89	1.16	0.21	0
1993	1179	243449	2421	185	2236	7.64	20.65	2.05	0.99	0.08	0
1994	1204	242252	2448	294	2154	12.01	20.12	2.03	1.01	0.12	0
1995(P)	1229	320657	1662	220	1442	13.24	26.09	1.35	0.52	0.07	0

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

35. District : Krisnagiri (Dharmapuri Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	1229	106465	704	33	671	4.68	8.66	0.05	0.66	0.03	0
1992	1254	18350	189	134	55	70.89	1.46	0.01	1.02	0.73	0
1993	1374	130839	547	14	533	2.56	9.52	0.40	0.42	0.01	0
1994	1405	103693	310	3	307	0.97	7.38	0.22	0.30	0.00	0
1995(P)											

36. District : Coimbatore (Coimbatore Division)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3370	460093	64	0	64	0.00	13.65	0.02	0.01	0.00	0
1987	3370	494719	64	2	62	3.13	14.68	0.02	0.01	0.00	0
1988	3485	250689	38	1	37						
1989	3562	208270	213	0	213						
1990	3580	201116	44	0	44						
1991	1200										
1992	3604	264328	19	0	19	0.00	7.33	0.01	0.01	0.00	0
1993	1743	166786	12	1	11	8.33	9.57	0.01	0.01	0.00	0
1994	1766	171185	17	0	17	0.00	9.69	0.01	0.01	0.00	0
1995(P)	1803	300575	33	0	33	0.00	16.67	0.02	0.01	0.00	0

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

37. District : Tiruppur (Coimbatore Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	1020	76613	11	1	10	9.09	7.50	0.01	0.01	0.00	0
1992	1033	102955	4	0	4	0.00	9.96	0.00	0.00	0.00	0
1993	1889	125770	5	0	5	0.00	6.66	0.00	0.00	0.00	0
1994	1920	139177	21	0	21	0.00	7.24	0.01	0.01	0.00	0
1995(P)											

38. District : Periyar Division

1985											
1986	2240	290532	3527	124	3403	3.52	12.97	1.57	1.21	0.04	0
1987	2441	295944	6940	554	6386	7.98	12.12	2.84	2.35	0.19	0
1988	2300	162186	7830	754	7076						
1989	2332	143404	5776	612	4764						
1990	2344	224875	5187	503	4684						
1991											
1992	2361	347293	4640	318	4326	6.85	14.71	1.97	1.34	0.09	0
1993	1650	304350	4279	163	4116	3.81	18.45	2.59	1.41	0.05	0
1994											
1995(P)	1684	247521	1443	37	1406	2.56	14.70	0.86	0.58	0.01	0

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

39. District : Dharapuram (Periyar Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991	644	79872	94	3	91	3.19	12.40	0.01	0.11	0.00	0
1992	654	92611	26	0	26	0.00	14.16	0.00	0.02	0.00	0
1993	737	84936	24	0	24	0.00	11.52	0.03	0.03	0.00	0
1994	746	80473	24	0	24	0.00	10.79	0.03	0.03	0.00	0
1995(P)											

40. District : Udhagamandalam (The Nilgiri Division)

1985											
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	435	31152	6	2	4	33.33	7.16	0.01	0.02	0.01	0
1994	741	48161	21	0	21	0.00	6.50	0.03	0.04	0.00	0
1995(P)											

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

41. District : Coonoor (The Nilgiris Division.)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	297	21817	21	0	21	0.00	7.35	0.07	0.10	0.00	0
1994											
1995(P)											

Information for 1986 to 1990 is included in the Nilgiris Reserve District at slro 95

42. District : Chengelpattu

1985											
1986	4190	377244	954	25	929	2.62	9.00	0.23	0.25	0.01	0
1987	4190	320362	962	13	949	1.35	7.65	0.23	0.30	0.00	0
1988											
1989											
1990											
1991											
1992	4793	400730	3234	60	3174	1.86	8.36	0.67	0.81	0.01	0
1993											
1994											
1995(P)		375367	5476	48	5428	0.88			1.46	0.01	0

TAMILNADU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

43. District : North Arcot

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	4830	810253	988	64	924	6.48	16.78	0.20	0.12	0.01	0
1987	4830	752098	724	60	664	8.29	15.57	0.15	0.10	0.01	0
1988											
1989											
1990											
1991											
1992	3055	374475	1694	94	1600	5.55	12.26	0.55	0.45	0.03	0
1993											
1994											
1995(P)		299284	5720	2097	3623	36.66			1.91	0.70	0

44. District : South Arcot

1985											
1986	4570	722916	490	21	469	4.29	15.82	0.11	0.07	0.00	0
1987	4570	621906	280	20	260	7.14	13.61	0.06	0.05	0.00	0
1988											
1989											
1990											
1991											
1992	4975	552787	3739	358	3381	9.57	11.11	0.75	0.68	0.06	0
1993											
1994											
1995(P)		224818	264	7	257	2.65			0.12	0.00	0

45. District : The Nilgiris

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	720	84932	29	0	29	0.00	11.80	0.04	0.03	0.00	0
1987	720	85269	30	4	26	13.33	11.84	0.04	0.04	0.00	0
1988	759	50938	33	2	31	6.06	6.71	0.04	0.06	0.00	0
1989	783	55226	34	0	34	0.00	7.05	0.04	0.06	0.00	0
1990	787	51896	42	0	42	0.00	6.59	0.05	0.08	0.00	0
1991											
1992	716	40459	35	1	34	2.86	5.65	0.05	0.09	0.00	0
1993											
1994											
1995(P)		42400	31	0	31	0.00			0.07	0.00	0

TRIPURA - Districtwise & Yearwise Epidemiogical Data & Parameters (1985-1994)

1. District : Tripura(N)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	632	31610	2006	1917	89	95.56	5.00	3.17	6.35	6.06	0
1987	632	49316	2768	2638	130	95.30	7.80	4.38	5.61	5.35	0
1988	632	35205	1318	1095	223	83.08	5.57	2.09	3.74	3.11	1
1989	632	42013	1183	989	194	83.60	6.65	1.87	2.82	2.35	2
1990	632	55499	950	835	115	87.89	8.78	1.50	1.71	1.50	3
1991	696	45153	1134	992	142	87.48	6.49	1.63	2.51	2.20	7
1992	697	48874	2116	1841	275	87.00	7.01	3.04	4.33	3.77	0
1993	697	63804	2062	1757	305	85.21	9.15	2.96	3.23	2.75	0
1994	715	66809	1577	1282	295	81.29	9.34	2.21	2.36	1.92	7
1995											

2. District : Tripura(W)

1985											
1986	1140	69793	1759	1423	336	80.90	6.12	1.54	2.52	2.04	0
1987	1140	72171	1066	817	249	76.64	6.33	0.94	1.48	1.13	0
1988	1140	86908	988	803	185	81.28	7.62	0.87	1.14	0.92	0
1989	1140	88328	762	617	145	80.97	7.75	0.67	0.86	0.70	3
1990	1140	92604	697	587	110	84.22	8.12	0.61	0.75	0.63	0
1991	1289	77813	1848	1581	267	85.55	6.04	1.43	2.37	2.03	0
1992	1293	76838	1190	880	310	73.95	5.94	0.92	1.55	1.15	0
1993	1294	70490	1249	1053	196	84.31	5.45	0.97	1.77	1.49	0
1994	1326	92690	1996	1596	400	79.96	6.99	1.51	2.15	1.72	1
1995											

TRIPURA - Districtwise & Yearwise Epidemiogical Data & Parameters (1985-1994)

3. District : Tripura(S)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	625	52014	5553	4713	840	84.87	8.32	8.88	10.68	9.06	0
1987	625	48573	4273	3790	483	88.70	7.78	6.84	8.80	7.80	0
1988	625	51591	3872	3421	451	88.35	8.25	6.20	7.51	6.63	0
1989	625	50749	4046	2649	1397	65.47	8.12	6.47	7.97	5.22	0
1990	625	59492	4986	3646	1340	73.12	9.52	7.98	8.38	6.13	1
1991	765	47946	4010	2764	1246	68.93	6.27	5.24	8.36	5.76	0
1992	766	49681	6044	4249	1795	70.30	6.49	7.89	12.17	8.55	0
1993	766	51271	5895	4413	1482	74.86	6.69	7.70	11.50	8.61	0
1994	786	72744	5298	4097	1201	77.92	9.25	6.75	7.29	5.63	12
1995											

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

1. District : Agra

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3234	153000	4026	262	3764	6.51	4.73	1.24	2.63	0.17	0
1987	3234	155000	2104	48	2056	2.28	4.79	0.65	1.36	0.03	0
1988	3626	169000	1780	79	1701	4.44	4.66	0.49	1.05	0.05	0
1989	3626	170000	1232	28	1204	2.27	4.69	0.34	0.72	0.02	0
1990	3040	150000	1053	137	916	13.01	4.93	0.35	0.70	0.09	0
1991	3111	163000	682	53	629	7.77	5.24	0.22	0.42	0.03	0
1992	3111	110032	2199	486	1713	22.10	3.54	0.70	1.99	0.44	0
1993	3165	141000	1782	180	1602	10.10	4.45	0.56	1.26	0.13	0
1994	3276	122000	941	62	879	6.59	3.72	0.29	0.77	0.05	0
1995(P)	3344	133488	1366	159	127	11.64	3.99	0.41	1.02	0.12	0

2. District: Aligarh

1985											
1986	2848	179000	4414	763	3651	17.29	6.29	1.55	2.47	0.43	0
1987	2909	201000	1435	118	1317	8.22	6.91	0.49	0.71	0.06	0
1988	2947	230000	1841	263	1578	14.29	7.80	0.62	0.80	0.11	0
1989	2947	211000	2009	284	1725	14.14	7.16	0.68	0.95	0.13	0
1990	2950	237000	2044	278	1766	13.60	8.03	0.69	0.86	0.12	0
1991	2950	248000	2443	229	2214	9.37	8.41	0.83	0.99	0.09	0
1992	2950	173487	2692	479	2213	17.79	5.88	0.91	1.55	0.27	0
1993	2950	227000	2940	462	2478	15.71	7.69	6.99	1.30	0.20	0
1994	3205	234000	1788	507	1281	28.36	7.30	0.56	0.76	0.22	0
1995(P)	3272	243045	2063	800	1203	41.69	93.41	7.43	0.63	0.85	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (19851995)

3. District : Meerut

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3450	212000	5844	219	5625	3.75	6.14	1.69	2.76	0.10	0
1987	3500	197000	1660	34	1626	2.05	5.63	0.47	0.84	0.02	0
1988	3600	236000	1455	67	1388	4.60	6.56	0.40	0.62	0.03	1
1989	3600	201000	832	9	823	1.08	5.58	0.23	0.41	0.00	0
1990	3600	209000	623	3	620	0.48	5.81	0.17	0.30	0.00	0
1991	3619	195000	348	17	331	4.89	5.39	0.10	0.18	0.01	0
1992	3619	100715	278	5	273	1.79	2.78	0.07	0.27	0.00	0
1993	3619	173000	172	3	169	1.74	4.78	0.04	0.10	0.00	0
1994	3619	174000	212	1	211	0.47	4.80	0.05	0.12	0.00	0
1995(P)	3250	164828	437	9	428	2.06	5.07	0.13	0.27	0.01	0

4. District : Bijnor

1985											
1986	2350	166000	4222	93	4129	2.20	7.06	1.80	2.54	0.06	0
1987	2350	161000	2074	34	2040	1.64	6.85	0.88	1.29	0.02	0
1988	2400	224000	1588	23	1565	1.45	9.33	0.66	0.71	0.01	0
1989	2400	207000	886	9	877	1.02	8.63	0.37	0.43	0.00	0
1990	2400	195000	1648	9	1639	0.55	8.13	0.69	0.85	0.00	0
1991	2400	211000	1502	5	1497	0.33	8.79	0.63	0.71	0.00	0
1992	2400	156730	939	2	937	0.21	6.53	0.39	0.60	0.00	0
1993	2525	189000	1143	9	1134	0.79	7.49	0.45	0.60	0.00	0
1994	2569	159000	927	8	919	0.86	6.19	0.36	0.58	0.01	0
1995(P)	2622	161694	1337	4	1333	0.30	6.17	0.51	0.83	0.00	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

5. District : Firozabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985		New Distt. created in 1991									
1986											
1987											
1988											
1989											
1990											
1991	1605	117000	237	19	218	8.02	7.29	0.15	0.20	0.02	0
1992	1622	119000	848	66	782	7.78	7.34	0.52	0.71	0.06	0
1993	1624	108000	437	46	391	10.53	6.65	0.27	0.40	0.04	0
1994	1624	104000	257	55	202	21.40	6.40	0.16	0.25	0.05	0
1995(P)	1658	108919	480	34	446	7.08	6.57	0.29	0.44	0.03	0

6. District : Mathura

1985											
1986	1681	140000	1973	266	1707	13.48	8.33	1.17	1.41	0.19	0
1987	1681	130000	745	74	671	9.93	7.73	0.44	0.57	0.06	0
1988	1759	159000	1034	127	907	12.28	9.04	0.59	0.65	0.08	0
1989	1759	149000	1125	251	874	22.31	8.47	0.64	0.76	0.17	0
1990	1854	160000	1243	286	957	23.01	8.63	0.67	0.78	0.18	0
1991	1973	173000	1200	198	1002	16.50	8.77	0.61	0.69	0.11	0
1992	1973	100715	2242	866	1376	38.62	5.10	1.13	2.22	0.85	0
1993	2025	189000	1993	396	1597	19.87	9.33	0.98	1.05	0.21	0
1994	2025	238000	1044	317	727	30.36	11.75	0.52	0.44	0.13	0
1995(P)	2067	181332	1090	239	851	21.93	8.77	0.53	0.60	0.13	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

7. District : Bulandshar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2610	170000	7732	580	7152	7.50	6.51	2.96	4.55	0.34	0
1987	2657	141000	2114	138	1976	6.53	5.31	0.80	1.50	0.10	0
1988	2713	157000	2231	260	1971	11.65	5.79	0.82	1.42	0.17	0
1989	2713	149000	1035	55	980	5.31	5.49	0.38	0.69	0.04	0
1990	2715	159000	1174	47	1127	4.00	5.86	0.43	0.74	0.03	0
1991	2828	152000	1448	20	1428	1.38	5.37	0.51	0.95	0.01	0
1992	2828	110024	885	7	878	0.79	3.89	0.31	0.80	0.01	0
1993	2873	113000	1065	21	1044	1.97	3.93	0.37	0.94	0.02	0
1994	2873	118000	1993	86	1907	4.32	4.11	0.69	1.69	0.07	0
1995(P)	2933	118807	2314	191	2123	8.25	4.05	0.79	1.95	0.16	0

8. District : Ghaziabad

1985											
1986	1831	143000	3709	47	3662	1.27	7.81	2.03	2.59	0.03	0
1987	1993	131000	1136	6	1130	0.53	6.57	0.57	0.87	0.00	0
1988	2010	160000	2032	183	1849	9.01	7.96	1.01	1.27	0.11	0
1989	2010	146000	3361	73	3288	2.17	7.26	1.67	2.30	0.05	0
1990	2116	150000	1487	27	1460	1.82	7.09	0.70	0.99	0.02	0
1991	2116	146000	406	11	395	2.71	6.90	0.19	0.28	0.01	0
1992	2116	105250	330	34	296	10.30	4.97	0.16	0.31	0.03	0
1993	2030	130000	654	4	650	0.61	6.40	0.32	0.50	0.00	0
1994	2073	128000	744	13	731	1.75	6.17	0.36	0.58	0.01	0
1995(P)	2116	126020	918	6	912	0.65	5.96	0.43	0.73	0.00	0

9. District : Muzaffarnagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2582	232000	10686	376	10310	3.52	8.99	4.14	4.61	0.16	0
1987	2708	170000	4423	16	4407	0.36	6.28	1.63	2.60	0.01	0
1988	2740	208000	3830	47	3783	1.23	7.59	1.40	1.84	0.02	0
1989	2740	174000	2921	55	2866	1.88	6.35	1.07	1.68	0.03	0
1990	2830	170000	2453	67	2386	2.73	6.01	0.87	1.44	0.04	0
1991	2941	157000	1741	14	1727	0.80	5.34	0.59	1.11	0.01	0
1992	2941	79854	271	0	271	0.00	2.72	0.09	0.34	0.00	0
1993	2966	142000	1170	9	1161	0.77	4.79	0.39	0.82	0.01	0
1994											
1995(P)	3105	162526	2185	269	1916	12.31	5.23	0.70	1.34	0.17	0

10. District : Saharanpur

1985											
1986	2714	134000	11909	1313	10596	11.03	4.94	4.39	8.89	0.98	0
1987	2781	95000	5766	535	5231	9.28	3.42	2.07	6.07	0.56	0
1988	2845	166000	6173	130	6043	2.11	5.83	2.17	3.72	0.08	0
1989	2845	43000	831	6	825	0.72	1.51	0.29	1.93	0.01	0
1990	2070	141000	4640	61	4579	1.31	6.81	2.24	3.29	0.04	0
1991	2073	159000	4060	15	4045	0.37	7.67	1.96	2.55	0.01	0
1992	2073	157000	3043	15	3028	0.49	7.57	1.47	1.94	0.01	0
1993	2087	152000	2265	10	2255	0.44	7.28	1.09	1.49	0.01	0
1994	2152	139000	1510	2	1508	0.13	6.46	0.70	1.09	0.00	0
1995(P)	2197	172498	1468	3	1465	0.20	7.85	0.67	0.85	0.00	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

11. District : Haridwar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1990										
1986											
1987											
1988											
1989											
1990	939	45000	1172	15	1157	1.28	4.79	1.25	2.60	0.03	0
1991	939	52000	1125	3	1122	0.27	5.54	1.20	2.16	0.01	0
1992	939	53000	587	1	586	0.17	5.64	0.63	1.11	0.00	0
1993	924	42000	326	0	326	0.00	4.55	0.35	0.78	0.00	0
1994	1076	42000	136	0	136	0.00	3.90	0.13	0.32	0.00	0
1995(P)	1098	38268	239	1	238	0.42	3.49	0.22	0.62	0.00	0

12. District : Badaun

1985											
1986	2194	196000	32424	1934	30490	5.96	8.93	14.78	16.54	0.99	0
1987	2244	147000	14142	572	13570	4.04	6.55	6.30	9.62	0.39	0
1988	2275	116000	19369	472	18897	2.44	5.10	8.51	16.70	0.41	0
1989	2275	172000	15912	109	15803	0.69	7.56	6.99	9.25	0.06	0
1990	2390	186000	14651	216	14435	1.47	7.78	6.13	7.88	0.12	0
1991	2486	192000	15379	165	15214	1.07	7.72	6.19	8.01	0.09	0
1992	2486	137456	11555	20	11535	0.17	5.53	4.65	8.41	0.01	0
1993	2632	172000	11681	27	11654	0.23	6.53	4.44	6.79	0.02	0
1994	2681	174000	9927	18	9909	0.18	6.49	3.70	5.71	0.01	0
1995(p)	2737	175051	6250	20	6230	0.32	6.40	2.28	3.57	0.01	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

13. District : Shahjahanpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1800	180000	23169	4113	19056	17.75	10.00	12.87	12.87	2.29	0
1987	1800	146000	11016	1647	9369	14.95	8.11	6.12	7.55	1.13	0
1988	1850	178000	12298	1383	10915	11.25	9.62	6.65	6.91	0.78	0
1989	1850	160000	10519	772	9747	7.34	8.65	5.69	6.57	0.48	0
1990	1850	148000	5869	225	5644	3.83	8.00	3.17	3.97	0.15	0
1991	1850	166000	3932	35	3897	0.89	8.97	2.13	2.37	0.02	0
1992	1850	116951	2348	9	2339	0.38	6.32	1.27	2.01	0.01	0
1993	1906	148000	1867	27	1840	1.45	7.76	0.98	1.26	0.02	0
1994	1906	139000	1511	124	1387	8.21	7.29	0.79	1.09	0.09	0
1995(p)	1027	132887	950	84	866	8.84	12.94	0.93	0.71	0.06	0

14. District : Nainital

1985											
1986	1247	249000	24341	1108	23233	4.55	19.97	19.52	9.78	0.44	0
1987	1274	204000	15103	636	14467	4.21	16.01	11.85	7.40	0.31	0
1988	1307	195000	11380	331	11049	2.90	14.92	8.70	5.83	0.17	0
1989	1307	172000	7679	191	7488	2.49	13.16	5.88	4.46	0.11	0
1990	1307	159000	5041	61	4980	1.21	12.16	3.85	3.17	0.04	0
1991	1419	167000	3297	45	3252	1.36	11.77	2.32	1.97	0.03	0
1992	1419	121416	2485	24	2461	0.97	8.56	1.75	2.05	0.02	0
1993	1525	139000	2697	147	2550	5.45	9.11	1.77	1.94	0.11	0
1994	1525	111000	1612	65	1547	4.03	7.28	1.06	1.45	0.06	0
1995(p)	1557	116929	1635	38	1597	2.32	7.51	1.05	1.40	0.03	0

15. District : Jhansi

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1165	89000	5444	1540	3904	28.28	7.64	4.67	6.12	1.73	0
1987	1165	85000	3991	1104	2887	27.66	7.30	3.43	4.70	1.30	0
1988	1200	144000	5076	1136	3940	22.38	12.00	4.23	3.53	0.79	0
1989	1200	121000	3454	496	2958	14.36	10.08	2.88	2.85	0.41	0
1990	1260	129000	2816	685	2131	24.33	10.24	2.23	2.18	0.53	0
1991	1279	140000	3409	1097	2312	32.18	10.95	2.67	2.44	0.78	0
1992	1279	70296	1778	343	1435	19.29	5.50	1.39	2.53	0.49	0
1993	1304	99000	2658	598	2060	22.50	7.59	2.03	2.68	0.60	0
1994	1333	98000	3581	1254	2327	35.02	7.35	2.69	3.65	1.28	0
1995(p)	1360	108271	3059	673	2386	22.00	7.96	2.25	2.83	0.62	0

16. District : Jalaun

1985											
1986	1100	83000	1120	422	698	37.68	7.55	1.02	1.35	0.51	0
1987	1100	73000	774	136	638	17.57	6.64	0.70	1.06	0.19	0
1988	1125	87000	1036	294	742	28.38	7.73	0.92	1.19	0.34	0
1989	1125	72000	308	51	257	16.56	6.40	0.27	0.43	0.07	0
1990	1125	74000	266	85	181	31.95	6.58	0.24	0.36	0.11	0
1991	1125	96000	1005	364	641	36.22	8.53	0.89	1.05	0.38	0
1992	1125	51068	953	307	646	32.21	4.54	0.85	1.87	0.60	0
1993	1125	84000	818	263	555	32.15	7.46	0.72	0.97	0.31	0
1994	1125	76000	1017	405	612	39.82	6.75	0.90	1.34	0.53	0
1995(p)	1122	100610	1950	564	1386	28.92	8.97	1.74	1.94	0.56	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

17. District : Hamirpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1324	116000	4121	759	3362	18.42	8.76	3.11	3.55	0.65	0
1987	1355	116000	2977	359	2618	12.06	8.56	2.20	2.57	0.31	0
1988	1378	144000	4225	362	3863	8.57	10.45	3.07	2.93	0.25	0
1989	1378	129000	2450	235	2215	9.59	9.36	1.78	1.90	0.18	0
1990	1378	143000	2600	363	2237	13.96	10.38	1.89	1.82	0.25	0
1991	1457	171000	6054	898	5156	14.83	11.74	4.16	3.54	0.53	0
1992	1457	119707	8869	271	8598	3.06	8.22	6.09	7.41	0.23	0
1993	1540	148000	5803	310	5493	5.34	9.61	3.77	3.92	0.21	0
1994	1552	171000	5675	459	5216	8.09	11.02	3.66	3.32	0.27	0
1995(p)	1584	138528	6079	318	5761	5.23	8.75	3.84	4.39	0.23	0

18. District : Lalitpur

1985											
1986	619	55000	950	155	795	16.32	8.89	1.53	1.73	0.28	0
1987	630	54000	2238	517	1721	23.10	8.57	3.55	4.14	0.96	0
1988	700	66000	1297	204	1093	15.73	9.43	1.85	1.97	0.31	0
1989	700	86000	905	158	747	17.46	12.29	1.29	1.05	0.18	0
1990	700	96000	1106	172	934	15.55	13.71	1.58	1.15	0.18	0
1991	700	99000	1175	122	1055	10.38	14.14	1.68	1.19	0.12	0
1992	700	66479	836	81	755	9.69	9.50	1.19	1.26	0.12	0
1993	742	86000	1696	140	1556	8.25	11.59	2.28	1.97	0.16	0
1994	776	99000	1168	64	1104	5.48	12.76	1.51	1.18	0.06	0
1995(p)	792	108225	1443	66	1377	4.57	13.66	1.82	1.33	0.06	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

19. District : Allahabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3850	222000	6743	1101	5642	16.33	5.77	1.75	3.04	0.50	0
1987	3900	259000	4958	471	4487	9.50	6.64	1.27	1.91	0.18	0
1988	3950	296000	7133	1365	5768	19.14	7.49	1.81	2.41	0.46	0
1989	3950	326000	10856	2567	8289	23.65	8.25	2.75	3.33	0.79	0
1990	3950	376000	12078	3753	8325	31.07	9.52	3.06	3.21	1.00	0
1991	3970	377000	11537	3331	8206	28.87	9.50	2.90	3.06	0.88	0
1992	3970	242991	8374	784	7590	9.36	6.12	2.11	3.45	0.32	0
1993	4200	236000	8071	839	7232	10.40	5.62	1.92	3.42	0.36	0
1994	4200	265000	6954	1248	5706	17.95	6.31	1.66	2.62	0.47	0
1995(p)	4288	251501	5658	592	5066	10.46	5.89	1.32	2.24	0.23	0

20. District : Moradabad

1985											
1986	2931	236000	13191	882	12309	6.69	8.05	4.50	5.59	0.37	0
1987	3443	223000	7133	175	6958	2.45	6.48	2.07	3.20	0.08	0
1988	3490	274000	5865	109	5756	1.86	7.85	1.68	2.14	0.04	0
1989	3490	270000	4646	84	4562	1.81	7.74	1.33	1.72	0.03	0
1990	3672	284000	4207	25	4182	0.59	7.73	1.15	1.48	0.01	0
1991	3717	284000	4949	15	4934	0.30	7.64	1.33	1.74	0.01	0
1992	3827	315000	3395	4	3391	0.12	8.23	0.89	1.08	0.00	0
1993	3827	256000	2440	1	2439	0.04	6.68	0.63	0.95	0.00	0
1994	3827	120000	820	1	819	0.12	3.13	0.21	0.68	0.00	0
1995(p)	1586	251898	2042	7	2035	0.34	15.88	1.29	0.81	0.00	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

21. District : Sonbhadra

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985		New Distt. created in 1990									
1986											
1987											
1988											
1989											
1990	1072	94000	12251	212	12039	1.73	8.77	11.43	13.03	0.23	0
1991	1172	91000	13256	448	12808	1.37	7.76	11.32	14.56	0.49	0
1992	1100	110000	17196	508	16688	2.95	10.00	15.63	15.63	0.46	0
1993	1172	115000	24097	962	23135	3.99	9.81	20.56	20.95	0.84	0
1994	699	69000	15411	922	14489	5.98	9.87	22.05	22.33	1.34	0
1995(p)	713	124145	30075	972	29103	3.23	17.41	42.18	24.23	0.78	0

22. District : Etah

1985											
1986	2200	164000	1282	26	1256	2.03	7.45	0.58	0.78	0.02	0
1987	2200	181000	403	3	400	0.74	8.23	0.18	0.22	0.00	0
1988	2253	214000	450	9	441	2.00	9.50	0.20	0.21	0.00	0
1989	2253	195000	309	6	303	1.94	8.66	0.14	0.16	0.00	0
1990	2308	191000	515	4	511	0.78	8.28	0.22	0.27	0.00	0
1991	2422	198000	464	64	400	13.79	8.18	0.19	0.23	0.03	0
1992	2445	192000	1676	265	1411	15.81	7.85	0.69	0.87	0.14	0
1993	2446	154000	1074	78	996	7.26	6.30	0.44	0.70	0.05	0
1994	2446	152000	529	48	481	9.07	6.21	0.22	0.35	0.03	0
1995(p)	2497	165659	650	56	594	8.62	6.63	0.26	0.39	0.03	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

23. District : Bareilly

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2350	128000	2108	159	1949	7.54	5.45	0.90	1.65	0.12	0
1987	2400	138000	1140	140	1000	12.28	5.75	0.48	0.83	0.10	0
1988	2450	218000	161	23	138	14.29	8.90	0.07	0.07	0.01	0
1989	2450	169000	928	1	927	0.11	6.90	0.38	0.55	0.00	0
1990	2500	166000	703	1	702	0.14	6.64	0.28	0.42	0.00	0
1991	2500	172000	592	2	590	0.34	6.88	0.24	0.34	0.00	0
1992	2500	164000	844	1	843	0.12	6.56	0.34	0.51	0.00	0
1993	2500	156000	1655	2	1653	0.12	6.24	0.66	1.06	0.00	0
1994	2500	132000	865	1	864	0.12	5.28	0.34	0.66	0.00	0
1995(P)	2391	134276	1314	36	1278	2.74	5.62	0.55	0.98	0.03	0

24. District : Farrukhabad

1985											
1986	2124	118000	3085	29	3056	0.94	5.56	1.45	2.61	0.02	0
1987	2124	112000	1676	0	1676	0.00	5.27	0.79	1.50	0.00	0
1988	2150	143000	1159	18	1141	1.55	6.65	0.54	0.81	0.01	0
1989	2150	135000	772	0	772	0.00	6.28	0.36	0.57	0.00	0
1990	2173	137000	771	5	766	0.65	6.30	0.35	0.56	.00	0
1991	2179	149000	2147	421	1726	19.61	6.84	0.99	1.44	0.28	0
1992	2179	196000	3235	40	3195	1.24	8.99	1.48	1.65	0.02	0
1993	2308	173000	2787	174	2613	6.24	7.50	1.21	1.61	0.10	0
1994	2440	156000	2537	99	2438	3.90	6.39	1.04	1.63	0.06	0
1995(p)	2491	149302	2734	123	2611	4.50	5.99	1.10	1.83	0.08	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

25. District : Sultanpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2195	115000	1136	10	1126	0.88	5.24	0.52	0.99	0.01	0
1987	2195	117000	878	7	871	0.80	5.33	0.40	0.75	0.01	0
1988	2215	143000	791	2	789	0.25	6.46	0.36	0.55	0.00	0
1989	2215	155000	602	1	601	0.17	7.00	0.27	0.39	0.00	0
1990	2274	150000	1316	0	1316	0.00	6.60	0.58	0.88	0.00	0
1991	2340	151000	3837	6	3831	0.16	6.45	1.64	2.54	0.00	0
1992	2340	150000	3285	0	3285	0.00	6.41	1.40	2.19	0.00	0
1993	2420	102000	1794	4	1790	0.22	4.21	0.74	1.76	0.00	0
1994	2504	91000	1192	1	1191	0.08	3.63	0.48	1.31	0.00	0
1995(P)	2556	95614	860	0	860	0.00	3.74	0.34	0.90	0.00	0

26. District : Mainpuri

1985											
1986	2000	145000	700	46	654	6.57	7.25	0.35	0.48	0.03	0
1987	2000	198000	145	7	138	4.83	9.90	0.07	0.07	0.00	0
1988	2050	218000	161	23	138	14.29	10.63	0.08	0.07	0.01	0
1989	2050	209000	200	13	187	6.50	10.20	0.10	0.10	0.01	0
1990	2100	137000	605	54	551	8.93	6.52	0.29	0.44	0.04	0
1991	2100	144000	764	111	653	14.53	6.86	0.36	0.53	0.08	0
1992	2100	143000	1449	358	1091	24.71	6.81	0.69	1.01	0.25	0
1993	2100	119000	1956	332	1624	16.97	5.66	0.93	1.64	0.28	0
1994	2100	114000	1281	366	915	28.57	5.42	0.61	1.12	0.32	0
1995(P)	1345	97523	1909	561	1348	29.39	7.25	1.42	1.96	0.58	0

27. District : Pauri

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	741	63000	3130	154	2976	4.92	8.50	4.22	4.97	0.24	0
1987	749	62000	1922	121	1801	6.30	8.28	2.57	3.10	0.20	0
1988	767	72000	2101	12	2089	0.57	9.39	2.74	2.92	0.02	0
1989	767	67000	1636	0	1636	0.00	8.74	2.13	2.44	0.00	0
1990	815	70000	998	0	998	0.00	8.59	1.22	1.43	0.00	0
1991	815	76000	728	0	728	0.00	9.33	0.89	0.96	0.00	0
1992	815	62000	533	0	533	0.00	7.61	0.65	0.86	0.00	0
1993	815	54000	387	0	387	0.00	6.62	0.47	0.72	0.00	0
1994	815	54000	387	0	387	0.00	6.62	0.47	0.72	0.00	0
1995(p)	759	48774	159	0	159	0.00	6.43	0.21	0.33	0.00	0

28. District : Etawaha

1985											
1986	1856	146000	924	73	851	7.90	7.87	0.50	0.63	0.05	0
1987	1861	147000	183	14	169	7.65	7.90	0.10	0.12	0.01	0
1988	1900	215000	397	41	356	10.33	11.32	0.21	0.18	0.02	0
1989	1900	195000	357	21	336	5.88	10.26	0.19	0.18	0.01	0
1990	1950	213000	497	59	438	11.87	10.92	0.25	0.23	0.03	0
1991	1950	195000	553	98	455	17.72	10.00	0.28	0.28	0.05	0
1992	1960	189000	2136	282	1854	13.20	9.64	1.09	1.13	0.15	0
1993	1976	137000	907	105	802	11.58	6.93	0.46	0.66	0.08	0
1994	1976	145000	957	159	798	16.61	7.33	048	0.66	0.11	0
1995(p)	1899	158484	1879	547	1332	29.11	8.35	0.99	1.19	0.35	0

29. District : Rai Bareley

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1942	132000	720	13	707	1.81	6.80	0.37	0.55	0.01	0
1987	1943	141000	316	12	304	3.80	7.26	0.16	0.22	0.01	0
1988	1977	165000	479	17	462	3.55	8.35	0.24	0.29	0.01	0
1989	1977	167000	328	7	321	2.13	8.45	0.17	0.20	0.00	0
1990	2069	172000	240	15	225	6.25	8.31	0.12	0.14	0.01	0
1991	2069	179000	450	50	400	11.11	8.65	0.22	0.25	0.03	0
1992	2069	154000	453	12	441	2.65	7.44	0.22	0.29	0.01	0
1993	2179	122000	180	22	158	12.22	5.60	0.08	0.15	0.02	0
1994	2360	138000	217	21	196	9.68	5.85	0.09	0.16	0.02	0
1995(P)	2409	153330	175	24	151	13.71	6.36	0.07	0.11	0.02	0

30. District : Barraich

1985											
1986	2453	213000	226	17	209	7.52	8.68	0.09	0.11	0.01	0
1987	2453	274000	55	1	54	1.82	11.17	0.02	0.02	0.00	0
1988	2463	280000	44	4	40	9.09	11.37	0.02	0.02	0.00	0
1989	2463	266000	53	0	53	0.00	10.80	0.02	0.02	0.00	0
1990	2500	261000	37	1	36	2.70	10.44	0.01	0.01	0.00	0
1991	2570	256000	80	0	80	0.00	9.96	0.03	0.03	0.00	0
1992	2570	247000	212	2	210	0.94	9.61	0.08	0.09	0.00	0
1993	2570	206000	204	17	187	8.33	8.01	0.07	0.10	0.01	0
1994	2570	191000	139	12	127	0.63	7.43	0.05	0.07	0.01	0
1995(P)	2612	178417	192	4	188	2.08	6.83	0.07	0.11	0.00	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

31. District : Dehradun

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	845	57000	1086	24	1062	2.21	6.75	1.29	1.91	0.04	0
1987	845	52000	380	10	370	2.63	6.15	0.45	0.73	0.02	0
1988	875	60000	331	0	331	0.00	6.86	0.38	0.55	0.00	0
1989	875	73000	355	11	344	3.10	8.34	0.41	0.49	0.02	0
1990	900	76000	586	6	580	1.02	8.44	0.65	0.77	0.01	0
1991	900	83000	651	1	650	0.15	9.22	0.72	0.78	0.00	0
1992	900	73714	376	1	375	0.27	8.19	0.42	0.51	0.00	0
1993	900	83000	192	0	192	0.00	9.22	0.21	0.23	0.00	0
1994	900	46000	182	1	181	0.55	5.11	0.20	0.40	0.00	0
1995(P)	862	88032	188	1	187	0.53	10.21	0.22	0.21	0.00	0

32. District : Varanasi

1985											
1986	3232	150000	520	21	499	4.04	4.64	0.16	0.35	0.01	0
1987	3300	172000	501	12	489	2.40	5.21	0.15	0.29	0.01	0
1988	3350	200000	570	19	551	3.33	5.97	0.17	0.29	0.01	0
1989	3350	207000	601	9	592	1.50	6.18	0.18	0.29	0.00	0
1990	3450	234000	777	21	756	2.70	6.78	0.23	0.33	0.01	0
1991	3450	240000	2564	646	1918	25.19	6.96	0.74	1.06	0.27	0
1992	3450	215000	3441	279	3162	8.11	6.23	1.00	1.60	0.13	0
1993	3434	238000	3659	190	3469	5.19	6.93	1.07	1.54	0.08	0
1994	3628	226000	2932	257	2675	8.77	6.23	0.81	1.30	0.11	0
1995(P)	3704	222716	2270	180	2090	7.93	6.01	0.61	1.02	0.08	0

33. District : Gonda

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2900	211000	169	1	168	0.59	7.28	0.06	0.08	0.00	0
1987	2991	253000	71	0	71	0.00	8.46	0.02	0.03	0.00	0
1988	3048	260000	59	0	59	0.00	8.53	0.02	0.02	0.00	0
1989	3048	259000	62	1	61	1.61	8.50	0.02	0.02	0.00	0
1990	3115	244000	51	1	50	1.96	7.83	0.02	0.02	0.00	0
1991	3155	271000	74	0	74	0.00	8.59	0.02	0.03	0.00	0
1992	3241	305000	71	4	67	5.63	9.41	0.02	0.02	0.00	0
1993	3333	304000	73	0	73	0.00	9.12	0.02	0.02	0.00	0
1994	3393	274000	44	1	43	2.27	8.08	0.01	0.02	0.00	0
1995(P)	3464	258498	35	8	27	22.86	7.46	0.01	0.01	0.00	0

34. District : Pratapgarh

1985											
1986	1927	89000	288	9	279	3.13	4.62	0.15	0.32	0.01	0
1987	1950	103000	361	33	328	9.14	5.28	0.19	0.35	0.03	0
1988	2000	128000	345	22	323	6.38	6.40	0.17	0.27	0.02	0
1989	2000	178000	270	12	258	4.44	5.9	0.13	0.22	0.01	0
1990	2050	117000	212	5	207	2.36	5.71	0.10	0.18	0.00	0
1991	2050	141000	441	24	417	5.44	6.88	0.22	0.31	0.02	0
1992	2093	152000	606	25	581	4.13	7.26	0.29	0.40	0.02	0
1993	2057	101000	467	24	443	5.14	4.91	0.23	0.46	0.02	0
1994	2057	76000	217	91	126	41.94	3.69	0.11	0.29	0.12	0
1995(P)	2100	77168	192	16	176	8.33	3.43	0.09	0.27	0.02	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

35. District : Sidarthnagar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	New Distt. created in 1990										
1986											
1987											
1988											
1989											
1990	1651	117000	132	4	128	3.03	7.09	0.08	0.11	0.00	0
1991	1686	140000	156	2	154	1.28	8.30	0.09	0.11	0.00	0
1992	1686	150000	589	9	580	1.53	8.90	0.35	0.39	0.01	0
1993	1710	137000	203	5	198	2.46	8.01	0.12	0.15	0.00	0
1994	1710	142000	243	3	240	1.23	8.30	0.14	0.17	0.00	0
1995(P)	1745	125132	269	18	251	6.69	7.17	0.15	0.21	0.01	0

36. District : Almora

1985											
1986	776	60000	5757	62	5695	1.08	7.73	7.42	9.60	0.10	0
1987	776	49000	4243	211	4032	4.97	6.31	5.47	8.66	0.43	0
1988	799	60000	5301	283	5018	5.34	7.51	6.63	8.84	0.47	0
1989	799	51000	2933	29	2904	0.99	6.38	3.67	5.75	0.06	0
1990	810	47000	1444	8	1436	0.55	5.80	1.78	3.07	0.02	0
1991	810	41000	668	19	649	2.84	5.06	0.82	1.62	0.04	0
1992	810	44000	587	4	583	0.68	5.43	0.72	1.33	0.01	0
1993	808	44000	673	6	667	0.89	5.45	0.83	1.53	0.01	0
1994	808	38000	185	5	180	2.70	4.70	0.23	0.49	0.01	0
1995(P)	824	17008	100	0	100	0.00	2.06	0.12	0.59	0.00	0

37. District : Banda

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1643	117000	1831	77	1754	4.21	7.12	1.11	1.56	0.07	0
1987	1684	163000	1322	13	1309	0.98	9.68	0.79	0.81	0.01	0
1988	1707	251000	1840	43	1797	2.34	14.70	1.08	0.73	0.02	0
1989	1707	179000	477	85	392	17.82	10.49	0.28	0.27	0.05	0
1990	1778	244000	2209	168	2041	7.61	13.72	1.24	0.91	0.07	0
1991	1803	228000	2279	181	2098	7.94	12.65	1.26	1.00	0.08	0
1992	1826	199000	3015	309	2706	10.25	10.90	1.65	1.52	0.16	0
1993	1852	175000	1544	94	1450	6.09	9.45	0.83	0.88	0.05	0
1994	1889	160000	1601	126	1475	7.87	8.47	0.85	1.00	0.08	0
1995(P)	1928	183071	1358	87	1271	6.41	9.50	0.70	0.74	0.05	0

38. District : Rampur

1985											
1986	1550	114000	6152	80	6072	1.30	7.35	3.97	5.40	0.07	0
1987	1550	128000	4940	168	4772	3.40	8.26	3.19	3.86	0.13	0
1988	1600	155000	7005	40	6965	0.57	9.69	4.38	0.52	0.03	0
1989	1600	127000	2552	4	2548	0.16	7.94	1.60	2.01	0.00	0
1990	1650	154000	3162	1	3161	0.03	9.33	1.92	2.05	0.00	0
1991	1650	153000	3003	2	3001	0.07	9.27	1.82	1.96	0.00	0
1992	1650	152000	3027	0	3027	0.00	9.21	1.83	1.99	0.00	0
1993	1650	139000	2690	0	2690	0.00	8.42	1.63	1.94	0.00	0
1994	1650	123000	2728	0	2728	0.00	7.45	1.65	2.22	0.00	0
1995	1684	114279	1795	0	1795	0.00	6.79	1.07	1.57	0.00	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985- 1995)

39. District : Pilibhit

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1136	67000	3210	135	3075	4.21	5.90	2.83	4.79	0.20	0
1987	1167	68000	2018	179	1839	8.87	5.83	1.73	2.97	0.26	0
1988	1187	81000	1411	98	1313	6.95	6.82	1.19	1.74	0.12	0
1989	1187	73000	741	22	719	2.97	6.15	0.62	1.02	0.03	0
1990	1198	71000	402	40	362	9.95	5.93	0.34	0.57	0.06	0
1991	1198	77000	257	3	254	1.17	6.43	0.21	0.33	0.00	0
1992	1270	87000	316	2	314	0.63	6.85	0.25	0.36	0.00	0
1993	1337	89000	140	3	137	2.14	6.66	0.10	0.16	0.00	0
1994	1350	90000	184	7	177	3.80	6.67	0.14	0.20	0.01	0
1995(P)	1378	88431	132	9	123	6.82	6.42	0.10	0.15	0.01	0

40. District : Teheri

1985											
1986	555	31000	616	5	611	0.81	5.59	1.11	1.99	0.02	0
1987	555	32000	138	0	138	0.00	5.77	0.25	0.43	0.00	0
1988	580	38000	83	1	82	1.20	6.55	0.14	0.22	0.00	0
1989	580	37000	60	1	59	1.67	6.38	0.10	0.16	0.00	0
1990	586	39000	170	0	170	0.00	6.66	0.29	0.44	0.00	0
1991	597	42000	23	0	23	0.00	7.04	0.04	0.05	0.00	0
1992	597	39000	17	0	17	0.00	6.53	0.03	0.04	0.00	0
1993	597	41000	14	0	14	0.00	6.86	0.02	0.03	0.00	0
1994	597	38000	7	0	7	0.00	6.36	0.01	0.02	0.00	0
1995(P)	595	44800	14	0	14	0.00	7.53	0.02	0.03	0.00	0

41. District : Mirzapur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	2343	169000	14561	1797	12764	12.34	7.21	6.21	8.62	1.06	0
1987	2343	165000	14049	2129	11920	15.15	7.04	6.00	8.51	1.29	0
1988	2403	200000	12613	1214	11399	9.62	8.32	5.25	6.31	0.61	0
1989	2403	181000	11044	322	10722	2.92	7.53	4.60	6.10	0.18	0
1990	1449	146000	5194	4	5190	0.08	10.08	3.58	3.56	0.00	0
1991	1449	182000	8114	9	8105	0.11	12.56	5.60	4.46	0.00	0
1992	1449	192000	10434	47	10387	0.45	13.25	7.20	5.43	0.02	0
1993	1686	168000	9938	14	9924	0.14	9.96	5.89	5.92	0.01	0
1994	1804	158000	9196	29	9167	0.32	8.76	5.10	5.82	0.02	0

42. District : Jaunpur

1985											
1986	2636	150000	136	8	128	5.88	5.69	0.05	0.09	0.01	0
1987	2646	182000	85	3	82	3.52					
1988	2675	228000	75	4	71	5.33	8.52	0.03	0.03	0.00	0
1989	2675	240000	120	8	112	6.66	8.97	0.04	0.05	0.00	0
1990	2686	229000	303	78	225	5.74	8.53	0.11	0.13	0.03	0
1991	2754	248000	711	106	605	14.91	9.01	0.26	0.29	0.04	0
1992	2754	273000	1656	190	1466	11.47	9.91	0.60	0.61	0.07	0
1993	2671	260000	2507	82	2425	3.27	9.73	0.94	0.96	0.03	0
1994	3013	244000	1009	79	930	7.83	8.10	0.33	0.41	0.03	0
1995(P)	3076	224692	626	35	591	5.59	7.30	0.20	0.28	0.02	0

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985 -1995)

43. District : Kanpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985		* Bifurcated into Kanpur Ngr. & Dehat									
1986	4034	156000	688	15	673	2.18	3.87	0.17	0.44	0.01	0
1987	4073	178000	390	12	378	3.08	4.37	0.10	0.22	0.01	0
1988	4089	188000	829	40	789	4.83	4.60	0.20	0.44	0.02	0
1989	4089	161000	581	26	555	4.48	3.94	0.14	0.36	0.02	0
1990	4123	163000	731	27	704	3.69	3.95	0.18	0.45	0.02	0
1991	4176	178000	944	50	894	5.30	4.26	0.23	0.53	0.03	0
1992	4411	232000	3790	393	3397	10.36	5.25	0.85	1.63	0.16	0
1993	4411	171000	2041	91	1950	4.45	7.72	0.92	1.19	0.05	0
1994	4411	148000	1580	67	1513	4.24	3.35	0.35	1.06	0.04	0
1995(P)	4503	40011	392	28	364	7.14	0.89	0.09	0.98	0.07	0

44. District : Uttar Kashi

1985											
1986	210	16000	581	5	576	0.86	7.62	2.77	3.63	0.03	0
1987	210	13000	147	0	147	0.00	6.19	0.70	1.13	0.00	0
1988	220	16000	129	0	129	0.00	7.27	0.59	0.81	0.00	0
1989	220	11000	62	0	62	0.00	5.00	0.28	0.56	0.00	0
1990	230	11000	63	0	63	0.00	4.78	0.27	0.57	0.00	0
1991	230	10000	43	0	43	0.00	4.35	0.19	0.43	0.00	0
1992	238	11000	27	0	27	0.00	4.62	0.11	0.25	0.00	0
1993	238	16000	14	0	14	0.00	6.72	0.06	0.09	0.00	0
1994	238	14000	9	0	9	0.00	5.88	0.04	0.06	0.00	0
1995											

45. District : Azam Garh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	3800	184000	157	1	156	0.64	4.84	0.04	0.09	0.00	0
1987	3800	195000	145	0	145	0.00	5.13	0.04	0.07	0.00	0
1988	3850	207000	110	0	110	0.00	5.38	0.03	0.05	0.00	0
1989	3850	220000	113	0	113	0.00	5.71	0.03	0.05	0.00	0
1990	2617	174000	83	0	83	0.00	6.65	0.03	0.05	0.00	0
1991	2617	164000	58	0	58	0.00	6.27	0.02	0.04	0.00	0
1992	2671	161000	48	0	48	0.00	6.03	0.02	0.03	0.00	0
1993	2816	140000	29	0	29	0.00	4.97	0.01	0.02	0.00	0
1994	2816	169000	21	0	21	0.00	6.00	0.01	0.01	0.00	0

46. District : Mau

1995 New Distt. created in 1990

1986											
1987											
1988											
1989											
1990	1096	75000	65	0	65	0.00	6.84	0.06	0.09	0.00	0
1991	1096	77000	92	0	92	0.00	7.03	0.08	0.12	0.00	0
1992	1219	104000	143	1	143	0.69	8.53	0.12	0.14	0.00	0
1993	1219	85000	144	0	144	0.00	6.97	0.12	0.17	0.00	0
1994	1373	80000	120	0	120	0.00	5.83	0.09	0.15	0.00	0
1995											

47. District : Ghazipur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2450	92000	115	1	114	0.87	3.76	0.05	0.13	0.00	0
1987	2450	90000	41	1	40	2.44	3.67	0.02	0.05	0.00	0
1988	2500	126000	34	2	32	5.88	5.04	0.01	0.03	0.00	0
1989	2500	104000	47	1	46	2.13	4.16	0.02	0.05	0.00	0
1990	2550	99000	19	0	19	0.00	3.88	0.01	0.02	0.00	0
1991	2550	96000	37	2	35	5.41	3.76	0.01	0.04	0.00	0
1992	2550	125000	62	2	60	3.23	4.90	0.02	0.05	0.00	0
1993	2550	134000	40	1	39	2.50	5.25	0.02	0.03	0.00	0
1994	2550	28000	22	0	22	0.00	1.09	0.01	0.08	0.00	0
1995											

48. District : Lucknow

1985											
1986	2400	110000	219	4	215	1.83	4.58	0.09	0.20	0.00	0
1987	2400	118000	124	1	123	0.81	4.92	0.05	0.11	0.00	0
1988	2450	126000	94	1	93	1.06	5.14	0.04	0.07	0.00	0
1989	2450	138000	136	0	136	0.00	5.63	0.06	0.10	0.00	0
1990	2550	141000	177	2	175	1.13	5.53	0.07	0.13	0.00	0
1991	2530	123000	79	0	79	0.00	4.86	0.03	0.06	0.00	0
1992	2530	119000	97	1	96	1.03	4.70	0.04	0.08	0.00	0
1993	2555	109000	79	0	79	0.00	4.26	0.03	0.07	0.00	0
1994	2555	101000	62	0	62	0.00	3.95	0.02	0.06	0.00	0
1995											

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

49. District : Barabanki

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2236	176000	197	6	191	3.05	7.87	0.09	0.11	0.00	0
1987	2236	167000	97	6	91	6.19	7.47	0.04	0.06	0.00	0
1988	2250	195000	95	2	93	2.11	8.67	0.04	0.05	0.00	0
1989	2250	181000	76	1	75	1.32	8.04	0.03	0.04	0.00	0
1990	2300	150000	82	1	81	1.22	6.52	0.04	0.05	0.00	0
1991	2300	153000	71	0	71	0.00	6.65	0.03	0.05	0.00	0
1992	2300	180000	293	1	292	0.34	7.83	0.13	0.16	0.00	0
1993	2300	160000	14	1	13	7.14	6.95	0.01	0.01	0.00	0
1994	2300	120000	13	0	13	0.00	5.21	0.01	0.01	0.00	0
1995											

50. District : Kheri

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2015	139000	996	163	833	16.37	6.90	0.49	0.72	0.12	0
1987	2070	149000	2030	523	1507	25.76	7.20	0.98	1.36	0.35	0
1988	2126	146000	1856	560	1296	30.17	6.87	0.87	1.27	0.38	0
1989	2126	146000	1822	399	1423	21.90	6.87	0.86	1.25	0.27	0
1990	2208	142000	1715	362	1353	21.11	6.43	0.78	1.21	0.25	0
1991	2292	141000	1113	123	990	11.05	6.15	0.49	0.79	0.09	0
1992	2306	183000	2515	563	1952	22.39	7.94	1.09	1.37	0.31	0
1993	2320	166000	1725	168	1557	9.74	7.16	0.74	1.04	0.10	0
1994	2365	118000	1721	409	1312	23.77	4.99	0.73	1.46	0.35	0
1995											

51. District : Chamoli

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	380	43000	425	10	415	2.35	11.32	1.12	0.99	0.02	0
1987	380	43000	262	7	255	2.67	11.32	0.69	0.61	0.02	0
1988	391	43000	466	1	465	0.21	11.00	1.19	1.08	0.00	0
1989	391	44000	232	0	232	0.00	11.25	0.59	0.53	0.00	0
1990	394	38000	104	2	102	1.92	9.64	0.26	0.27	0.01	0
1991	413	43000	60	0	60	0.00	10.41	0.15	0.14	0.00	0
1992	422	38000	39	1	38	2.56	9.00	0.09	0.10	0.00	0
1993	425	38000	56	0	56	0.00	8.94	0.13	0.15	0.00	0
1994	438	25000	13	0	13	0.00	5.71	0.03	0.05	0.00	0
1995											

52. District : Sitapur

1985											
1986	2375	114000	205	9	196	4.39	4.80	0.09	0.18	0.01	0
1987	2375	139000	45	5	40	11.11	5.85	0.02	0.03	0.00	0
1988	2393	172000	153	55	98	35.95	7.19	0.06	0.09	0.03	0
1989	2393	169000	55	11	44	20.00	7.06	0.02	0.03	0.01	0
1990	2430	179000	24	5	19	20.83	7.37	0.01	0.01	0.00	0
1991	2430	168000	24	1	23	4.17	6.91	0.01	0.01	0.00	0
1992	2450	190000	13	0	13	0.00	7.76	0.01	0.01	0.00	0
1993	2664	164000	6	0	6	0.00	6.16	0.00	0.00	0.00	0
1994	2664	164000	5	0	5	0.00	6.16	0.01	0.00	0.00	0
1995											

53. District : Faizabad

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2500	76000	236	1	235	0.42	3.04	0.09	0.31	0.00	0
1987	2500	73000	152	2	150	1.32	2.92	0.06	0.21	0.00	0
1988	2558	79000	122	4	118	3.28	3.09	0.05	0.15	0.01	0
1989	2558	84000	109	3	106	2.75	3.28	0.04	0.13	0.00	0
1990	2600	76000	88	1	87	1.14	2.92	0.03	0.12	0.00	0
1991	2600	95000	138	4	134	2.90	3.65	0.05	0.15	0.00	0
1992	2600	110000	121	2	119	1.65	4.23	0.05	0.11	0.00	0
1993	2718	113000	127	1	126	0.79	4.16	0.05	0.11	0.00	0
1994	2759	96000	106	1	105	0.94	3.48	0.04	0.11	0.00	0
1995											

54. District : Fatehpur

1985											
1986	1568	96000	298	23	275	7.72	6.12	0.19	0.31	0.02	0
1987	1568	100000	301	15	286	4.98	6.38	0.19	0.30	0.02	0
1988	1624	137000	156	14	142	8.97	8.44	0.10	0.11	0.01	0
1989	1624	149000	62	5	57	8.06	9.17	0.04	0.04	0.00	0
1990	1728	128000	89	13	76	14.61	7.41	0.05	0.07	0.01	0
1991	1893	138000	100	10	90	10.00	7.29	0.05	0.07	0.01	0
1992	1893	148000	203	8	195	3.94	7.82	0.11	0.14	0.01	0
1993	1912	114000	155	3	152	1.94	5.96	0.08	0.14	0.00	0
1994	1953	120000	85	9	76	10.59	6.14	0.04	0.07	0.01	0
1995											

55. District : Unnao

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1985	110000	971	45	926	4.63	5.54	0.49	0.88	0.04	0
1987	1985	113000	452	8	444	1.77	5.69	0.23	0.40	0.01	0
1988	2000	144000	433	4	429	0.92	7.20	0.22	0.30	0.00	0
1989	2000	152000	200	7	193	3.50	7.60	0.10	0.13	0.00	0
1990	2067	160000	100	3	97	3.00	7.74	0.05	0.06	0.00	0
1991	2104	190000	56	10	46	17.86	9.03	0.03	0.03	0.01	0
1992	2117	194000	24	11	13	45.83	9.16	0.01	0.01	0.01	0
1993	2169	167000	12	3	9	25.00	7.70	0.01	0.01	0.00	0
1994	2195	156000	16	8	8	50.00	7.11	0.01	0.01	0.01	0
1995											

56. District : Pithoragarh

1985											
1986	467	17000	2083	96	1987	4.61	3.64	4.46	12.25	0.56	0
1987	467	14000	1342	179	1163	13.34	3.00	2.87	9.59	1.28	0
1988	480	20000	2829	495	2234	17.50	4.17	5.89	14.15	2.48	0
1989	480	17000	1948	135	1813	6.93	3.54	4.06	11.46	0.79	0
1990	500						0.00	0.00			0
1991	524	8000	332	15	317	4.52	1.53	0.63	4.15	0.19	0
1992	524	3000	114	2	112	1.75	0.57	0.22	3.80	0.07	0
1993											
1994	524	6000	241	0	241	0.00	1.14	0.45	4.02	0.00	0
1995											

57. District : Ballia

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2000	154000	140	0	140	0.00	7.70	0.07	0.09	0.00	0
1987	2000	156000	65	0	65	0.00	7.80	0.03	0.04	0.00	0
1988	2050	191000	101	0	101	0.00	9.32	0.05	0.05	0.00	0
1989	2050	193000	73	0	73	0.00	9.41	0.04	0.04	0.00	0
1990	2100	196000	46	0	46	0.00	9.33	0.02	0.02	0.00	0
1991	2100	182000	67	0	67	0.00	8.67	0.03	0.04	0.00	0
1992	2100	190000	54	0	54	0.00	9.05	0.03	0.03	0.00	0
1993	2100	156000	18	0	18	0.00	7.42	0.01	0.01	0.00	0
1994	2100	158000	30	0	30	0.00	7.52	0.01	0.02	0.00	0
1995											

58. District : Basti

1985											
1986	3950	228000	558	5	553	0.90	5.77	0.14	0.24	0.00	0
1987	3950	266000	283	2	281	0.71	6.73	0.07	0.11	0.00	0
1988	4071	291000	197	0	197	0.00	7.15	0.05	0.07	0.00	0
1989	4071	143000	68	0	68	0.00	3.51	0.02	0.05	0.00	0
1990	2516	158000	56	2	54	3.57	6.28	0.02	0.04	0.00	0
1991	2542	160000	95	8	87	8.42	6.29	0.04	0.06	0.01	0
1992	2631	151000	131	29	102	22.14	5.74	0.05	0.09	0.02	0
1993	2568	154000	214	31	183	14.49	6.00	0.08	0.14	0.02	0
1994	2568	158000	267	44	223	16.48	6.15	0.10	0.17	0.03	0
1995											

UTTAR PRADESH - Districtwise & Yearwise Epidemiological Data & Parameters (19851995)

59. District : Hardoi

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2374	223000	5664	270	5394	4.77	9.39	2.39	2.54	0.12	0
1987	2413	205000	1075	36	1039	3.35	8.50	0.45	0.52	0.02	0
1988	2458	270000	956	120	836	12.55	10.98	0.39	0.35	0.04	0
1989	2458	256000	381	10	371	2.62	10.41	0.16	0.15	0.00	0
1990	2583	240000	225	4	221	1.78	9.29	0.09	0.09	0.00	0
1991	2640	273000	403	30	373	7.44	10.34	0.15	0.15	0.01	0
1992	2694	270000	343	15	328	4.37	10.02	0.13	0.13	0.01	0
1993	2735	189000	176	7	169	3.98	6.91	0.06	0.09	0.00	0
1994	2712	156000	113	11	102	9.73	5.75	0.04	0.07	0.01	0
1995											

60. District : Kanpur Dehat

1985	Bifurcated from kanpur Ngr. & Kanpur Dehat										
1986											
1987											
1988											
1989											
1990											
1991											
1992											
1993	2196	37000	215	8	207	3.72	1.68	0.10	0.58	0.02	0
1994	597	40000	218	18	200	8.26	6.70	0.37	0.55	0.05	0
1995											

61. District : Gorakhpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3777	267000	579	18	561	3.11	7.07	0.15	0.22	0.01	0
1987	3817	282000	251	7	244	2.79	7.39	0.07	0.09	0.00	0
1988	3844	279000	158	1	157	0.63	7.26	0.04	0.06	0.00	0
1989	3844	308000	90	1	89	1.11	8.01	0.02	0.03	0.00	0
1990	2384	170000	46	2	44	4.35	7.13	0.02	0.03	0.00	0
1991	2405	161000	76	2	74	2.63	6.69	0.03	0.05	0.00	0
1992	2520	125000	46	2	44	4.35	4.96	0.02	0.04	0.00	0
1993	2552	115000	47	2	45	4.26	4.51	0.02	0.04	0.00	0
1994	2606	130000	27	1	26	3.70	4.99	0.01	0.02	0.00	0
1995											

62. District : Maharajganj

1985	New Distt. created in 1990										
1986											
1987											
1988											
1989											
1990	1562	112000	42	0	42	0.00	7.17	0.03	0.04	0.00	0
1991	1594	121000	56	0	56	0.00	7.59	0.04	0.05	0.00	0
1992	1711	84000	28	0	28	0.00	4.91	0.02	0.03	0.00	0
1993	1751	103000	44	3	41	6.82	5.88	0.03	0.04	0.00	0
1994	1751	89000	62	6	56	9.68	5.08	0.04	0.07	0.01	0
1995											

63. District : Deoria

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	3682	206000	477	33	444	6.92	5.59	0.13	0.23	0.02	0
1987	3682	261000	364	9	355	2.47	7.09	0.10	0.14	0.00	0
1988	3960	336000	292	7	285	2.40	8.48	0.07	0.09	0.00	0
1989	3960	339000	334	3	331	0.90	8.56	0.08	0.10	0.00	0
1990	4072	326000	320	15	305	4.68	8.01	0.08	0.10	0.00	0
1991	4072	292000	533	8	525	1.50	7.17	0.13	0.18	0.00	0
1992	4072	273000	362	10	352	2.76	6.70	0.09	0.13	0.00	0
1993	4072	265000	257	13	244	5.06	6.51	0.06	0.10	0.00	0
1994	4072	263000	209	5	204	2.39	6.46	0.05	0.08	0.00	0
1995											

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Nadia

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3199	125936	173	14	159	8.09	3.94	0.05	0.14	0.01	0
1987	2813	173365	171	21	150	12.28	6.16	0.06	0.10	0.01	0
1988	2860	200055	156	11	145	7.05	06.99	0.05	0.08	0.01	0
1989	2910	171289	163	7	156	4.29	5.89	0.06	0.10	0.00	0
1990	2911	191516	129	8	121	6.20	6.58	0.04	0.07	0.00	0
1991	2926	194381	121	10	111	8.26	6.64	0.04	0.06	0.01	0
1992	2984	264098	192	9	183	4.69	8.85	0.06	0.07	0.00	0
1993	3043	289365	329	28	301	8.51	9.50	0.10	0.11	0.00	0
1994	3162	314426	556	75	481	13.49	9.94	0.18	0.18	0.02	0
1995(P)	3228	301727	554	84	470	15.16	9.35	0.17	0.18	0.03	0

2. District : 24 Paraganas (South)

1985											
1986	9048	144950	893	8	885	0.90	1.60	0.10	0.62	0.01	0
1987	8171	183264	748	12	736	1.60	2.24	0.09	0.41	0.01	0
1988	4621	152288	1006	2	1004	0.20	3.30	0.22	0.66	0.00	0
1989	4699	127162	671	1	670	0.01	2.71	0.14	5.29	0.00	0
1990	4703	106520	647	0	647	0.00	2.26	0.14	0.61	0.00	0
1991	4722	103727	476	4	472	0.84	2.20	0.10	0.46	0.00	0
1992	4815	121612	352	2	350	0.57	2.53	0.07	0.29	0.00	0
1993	4910	87156	122	1	121	0.81	1.77	0.02	0.13	0.00	0
1994	5013	156293	194	8	186	4 .12	3 .11	0.02	0.13	0.00	0
1995*	2846	126679	845	48	797	5.68	4.45	0.30	0.67	0.04	0

(P) # New Distt. created in 1996 (24 Paraganas. (North) @Diamond Harbour to be included in 1994.

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

3. District : 24 Parganas (North)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	Bifurcated in 1988										
1986											
1987											
1988	3686	117550	117	1	116	0.85	3.19	0.03	0.10	0.00	0
1989	3745	120130	113	9	104	7.96	3.21	0.03	0.09	0.01	0
1990	3748	119931	123	4	119	3.25	3.20	0.03	0.10	0.00	0
1991	3765	168118	166	5	161	3.01	4.47	0.04	0.10	0.00	0
1992	3839	230499	117	12	105	10.26	6.00	0.03	0.05	0.01	0
1993	3914	161542	132	27	105	20.45	4.12	0.03	0.08	0.01	0
1994	4064	195860	205	35	170	17.07	4.82	0.05	0.10	0.01	1
1995(P)	1978	177027	394	60	334	15.23	8.95	0.20	0.22	0.03	1

4. District : Murshidabad

1985											
1986	4004	114209	119	3	116	2.52	2.85	0.03	0.10	0.00	0
1987	3829	130675	96	2	94	2.08	3.41	0.03	0.07	0.00	0
1988	3892	199864	173	1	172	0.58	5.14	0.04	0.09	0.00	0
1989	3883	102325	151	3	148	1.99	2.64	0.04	0.15	0.00	0
1990	3956	88507	119	3	116	2.52	2.24	0.03	0.13	0.00	0
1991	3974	97106	88	5	83	5.68	2.44	0.02	0.09	0.01	0
1992	4052	119978	57	2	55	3.51	2.96	0.01	0.05	0.00	0
1993	4132	86667	65	1	64	1.53	2.09	0.01	0.07	0.00	0
1994	4482	104826	112	12	100	10.71	2.33	0.02	0.10	0.01	0
1995	3728	158268	344	35	309	10.17	4.25	0.09	0.22	0.02	3

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

5. District : Burdwan

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	5240	30773	32	0	32	0.00	0.59	0.01	0.10	0.00	0
1987	4799	116452	71	8	63	11.27	2.43	0.01	0.06	0.01	0
1988	4880	166129	62	2	60	3.23	3.40	0.01	0.04	0.00	0
1989	4960	102941	62	12	50	19.35	2.08	0.01	0.06	0.01	0
1990	4959	86295	71	12	59	16.90	1.74	0.01	0.08	0.01	0
1991	4983	91941	66	6	60	9.09	1.85	0.01	0.07	0.01	0
1992	5083	121109	56	1	55	1.79	2.38	0.01	0.05	0.00	0
1993	5183	103653	30	3	27	10.00	1.99	0.00	0.02	0.00	0
1994	4168	90226	49	7	42	14.28	2.16	0.01	0.05	0.00	0
1995(P)	2737	80806	88	4	84	4.55	2.95	0.03	0.11	0.00	1

6. District : Birdhum

1985											
1986	2340	57987	133	4	129	3.01	2.48	0.06	0.23	0.01	0
1987	2179	62861	122	5	117	4.10	2.88	0.06	0.19	0.01	0
1988	2210	43537	130	7	123	5.38	1.97	0.06	0.30	0.02	0
1989	2246	34320	82	0	82	0.00	1.53	0.04	0.24	0.00	0
1990	2050	34525	138	4	134	2.90	1.68	0.07	0.40	0.01	0
1991	2060	30148	209	5	204	2.39	1.46	0.10	0.69	0.02	0
1992	2101	61253	150	1	149	0.67	2.92	0.07	0.24	0.00	0
1993	2143	38994	221	2	119	0.90	1.81	0.10	0.56	0.00	0
1994	2468	48283	366	10	356	2.73	1.96	0.15	0.76	0.02	0
1995(P)	2519	34836	2409	0	2409	0.00	1.38	0.96	6.92	0.00	0

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

7. District : Hooghly

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3569	77402	48	1	47	2.08	2.17	0.01	0.06	0.00	0
1987	2987	80708	47	0	47	0.00	2.70	0.02	0.06	0.00	0
1988	3030	126763	97	4	93	4.12	4.18	0.03	0.08	0.00	0
1989	3073	80345	57	2	55	3.51	2.61	0.02	0.07	0.00	0
1990	3080	83587	32	3	29	9.38	2.71	0.01	0.04	0.00	0
1991	3095	84892	43	0	43	0.00	2.74	0.01	0.05	0.00	0
1992	3155	130799	36	1	35	2.78	4.15	0.01	0.03	0.00	0
1993	3217	135558	34	1	33	2.94	4.21	0.01	0.02	0.00	0
1994	3247	152490	87	11	76	12.64	4.70	0.02	0.05	0.00	1
1995	1064	149390	196	30	166	15.31	14.04	0.18	0.13	0.02	1

8. District : Howrah

1985											
1986	2479	56289	455	1	454	0.22	2.27	0.18	0.81	0.00	0
1987	2339	90074	170	0	170	0.00	3.85	0.07	0.19	0.00	0
1988	2472	107430	138	0	138	0.00	4.35	0.06	0.13	0.00	0
1989	2511	51205	84	0	84	0.00	2.04	0.03	0.16	0.00	0
1990	2513	73826	53	0	53	0.00	2.94	0.02	0.07	0.00	0
1991	2524	64507	65	0	65	0.00	2.56	0.03	0.10	0.00	0
1992	2573	91456	57	0	57	0.00	3.55	0.02	0.06	0.00	0
1993	2573	92882	67	2	65	2.98	3.53	0.02	0.07	0.00	0
1994	2583	91520	105	2	103	1.90	3.54	0.04	0.11	0.00	0
1995(P)	959	102701	264	18	246	6.82	10.71	0.28	0.26	0.02	0

9. District : Midnapore

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	7139	170599	3573	182	3391	5.09	2.39	0.50	2.09	0.11	0
1987	7140	223607	3566	128	3438	3.59	3.13	0.50	1.59	0.06	0
1988	7261	281029	3249	104	3145	3.20	3.87	0.45	1.16	0.04	0
1989	7382	197849	1624	56	1568	3.45	2.68	0.22	0.82	0.03	0
1990	7380	162800	1618	59	1559	3.65	2.21	0.22	0.99	0.04	1
1991	7119	298355	1865	112	1753	6.01	4.19	0.26	0.63	0.04	0
1992	7565	392624	1693	235	1458	13.88	5.19	0.22	0.43	0.06	0
1993	7715	289222	1001	59	942	5.89	3.74	0.12	0.34	0.02	0
1994	7941	346454	1022	54	968	5.28	4.36	0.12	0.29	0.01	1
1995(P)	3461	398260	1861	142	1719	7.63	11.51	0.54	0.47	0.04	0

10. District : Bankura

1985											
1986	2578	103663	377	40	337	10.61	4.02	0.15	0.36	0.04	0
1987	2460	154312	405	6	399	1.48	6.27	0.16	0.26	0.00	0
1988	2492	188146	496	17	479	3.43	7.55	0.20	0.26	0.01	0
1989	2530	138268	231	12	219	5.19	5.47	0.09	0.17	0.01	0
1990	2533	158853	258	8	250	3.10	6.27	0.10	0.16	0.01	0
1991	2543	172575	329	45	284	13.68	6.79	0.13	0.19	0.03	0
1992	2592	231319	328	30	298	9.15	8.92	0.13	0.14	0.01	0
1993	2644	210498	303	21	282	6.93	7.96	0.11	0.14	0.00	0
1994	2700	223132	499	92	407	18.43	8.26	0.18	0.22	0.04	0
1995	1948	237453	740	125	615	16.89	12.19	0.38	0.31	0.05	2

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

11. District : Purulia

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1943	112262	7083	3088	3995	43.60	5.78	3.65	6.31	2.75	0
1987	1950	151773	6830	2614	4216	38.27	7.78	3.50	4.50	1.72	0
1988	1980	119196	4855	1213	3642	24.98	6.02	2.45	4.07	1.02	2
1989	2000	77598	3527	808	2719	22.91	3.88	1.76	4.55	1.04	0
1990	2000	78179	3500	1021	2479	29.17	3.91	1.75	4.48	1.31	0
1991											
1992	2052	101870	4302	619	3683	14.39	4.96	2.10	4.22	0.61	0
1993	2083	96087	3690	648	3042	17.56	4.61	1.77	3.84	0.67	0
1994	2137	118150	4494	681	3813	15.15	5.53	2.10	3.80	0.58	1
1995	2181	129611	6174	1354	4820	21.93	5.94	2.83	4.76	1.04	0

12. District : Malda

1985											
1986	2237	53376	98	9	89	9.18	2.39	0.04	0.18	0.02	0
1987	2147	71681	153	18	135	11.76	3.34	0.07	0.21	0.03	0
1988	2180	99821	81	7	74	8.64	4.58	0.04	0.08	0.01	0
1989	2220	71607	160	18	142	11.25	3.23	0.07	0.22	0.03	0
1990	2221	112607	201	16	185	7.96	5.07	0.09	0.18	0.01	0
1991	2232	140046	269	17	252	6.32	6.27	0.12	0.19	0.01	0
1992	2276	144316	257	16	241	6.23	6.34	0.11	0.18	0.01	0
1993	2319	103888	48	1	47	2.08	4.47	0.02	0.04	0.00	0
1994	2600	109752	136	57	79	41.91	4.22	0.05	0.12	0.05	0
1995	2654	109517	441	107	334	24.26	4.13	0.17	0.40	0.10	4

13. District : West Dinajpur

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	2540	31828	33	0	33	0.00	1.25	0.01	0.10	0.00	0
1987	2459	27731	79	2	77	2.53	1.13	0.03	0.28	0.01	0
1988	2500	31905	137	18	119	13.14	1.28	0.05	0.43	0.06	3
1989	2540	35119	55	2	53	3.64	1.38	0.02	0.16	0.01	0
1990	2543	42565	46	1	45	2.17	1.67	0.02	0.11	0.00	0
1991	2555	29726	62	5	57	8.06	1.16	0.02	0.21	0.02	0
1992	2606	43129	90	1	89	1.11	1.65	0.03	0.21	0.00	0
1993	2730	46363	28	2	26	7.14	1.69	0.01	0.06	0.00	0
1994	2794	59733	106	10	96	9.43	2.13	0.03	0.17	0.01	0
1995(P)	1272	38652	88	0	88	0.00	3.04	0.07	0.23	0.00	2

14. District : Jalpaiguri

1985											
1986	2348	181803	19922	8476	11446	42.55	7.74	8.48	10.96	4.66	0
1987	2360	173371	13261	5448	7813	41.08	7.35	5.62	7.65	3.14	0
1988	2410	129005	7293	3428	3865	47.00	5.35	3.03	5.65	2.66	0
1989	2450	143241	11181	4751	6430	42.49	5.85	4.56	7.81	3.32	15
1990	2453	89884	6294	2098	4196	33.33	3.66	2.57	7.00	2.33	1
1991	2453	109667	13523	5007	8516	37.03	4.47	5.51	12.33	4.57	9
1992	2460	167268	21403	6942	14461	32.43	6.80	8.70	12.80	4.15	0
1993	2552	160664	18962	3626	15136	19.12	6.29	7.43	11.80	2.25	0
1994	2552	266291	42226	10792	31434	25.56	10.93	16.54	15.86	4.05	34
1995(P)	2525	182077	35534	7960	27574	22.40	7.21	14.07	19.52	4.37	19

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

15. District : Cooch Behar

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	1920	83197	3969	728	3241	18.34	4.33	2.07	4.77	0.88	0
1987	1864	110960	3569	344	3225	9.64	5.95	1.91	3.22	0.31	0
1988	1890	70035	683	64	619	9.37	3.71	0.36	0.98	0.09	0
1989	1920	72311	559	80	479	14.31	3.77	0.29	0.77	0.11	1
1990	1922	66501	578	96	482	16.61	3.46	0.30	0.87	0.14	2
1991	1931	59969	1672	325	1347	19.44	3.11	0.87	2.79	0.54	0
1992	1931	89580	1940	341	1599	17.58	4.64	1.00	2.17	0.38	0
1993	2005	63044	1387	432	955	31.14	3.14	0.69	2.20	0.68	0
1994	2124	119256	3435	611	2824	17.79	5.61	1.62	2.88	0.51	4
1995(P)	2168	96307	4128	1265	2863	30.64	4.44	1.90	4.29	1.31	5

16. District : Darjeeling

1985											
1986	1026	12846	989	644	345	65.12	1.25	0.96	7.70	5.01	0
1987	785	19545	382	182	200	47.64	2.49	0.49	1.95	0.93	0
1988	800	13588	117	20	97	17.09	1.70	0.15	0.86	0.15	0
1989	810	6890	102	59	43	57.84	0.85	0.13	1.48	0.86	0
1990	811	6076	31	6	25	19.35	0.75	0.04	0.51	0.10	0
1991	811	30366	249	130	119	52.21	3.74	0.31	0.82	0.43	0
1992	827	32931	131	20	111	15.27	3.98	0.16	0.40	0.06	0
1993	845	8326	219	91	128	41.55	0.98	0.25	2.63	1.09	0
1994	859	13079	241	59	182	24.48	1.52	0.28	1.84	0.45	0
1995(P)	877	13075	285	49	236	17.19	1.49	0.32	2.18	0.37	0

WEST BENGAL - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

17. District : Calcutta

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	3387	103830	15723	898	14825	5.71	3.07	4.64	15.14	0.86	0
1987	3341	61716	16237	613	15624	3.78	1.85	4.86	26.31	0.99	0
1988	8500	110131	17528	663	16865	3.78	1.30	2.06	15.92	0.60	0
1989	7817	109358	16802	718	16084	4.27	1.40	2.15	15.36	0.66	0
1990	7906	108071	13693	553	13140	4.04	1.37	1.73	12.67	0.51	0
1991	7817	98911	15665	713	14952	4.55	1.27	2.00	15.84	0.72	0
1992	7817	131056	17969	728	17241	4.05	1.68	2.30	13.71	0.56	0
1993	7900	104000	19500	1818	17682	9.32	1.32	2.46	18.75	1.74	0
1994	8917	126000	20450	2876	17574	14.06	1.41	2.29	16.23	2.28	9
1995(P)	9104	126832	35394	5191	30203	14.67	1.39	3.89	27.91	4.09	54

ANDAMAN & NICOBAR - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District: Andaman

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	210	80658	1035	116	919	11.21	38.41	4.93	1.28	0.14	0
1987	223	94326	1055	173	882	16.40	42.30	4.73	1.12	0.18	0
1988	232	98747	1060	122	938	11.51	42.56	4.57	1.07	0.12	0
1989	241	98945	823	59	764	7.17	41.06	3.41	0.83	0.06	1
1990	247	96089	710	55	655	7.75	38.90	2.87	0.74	0.06	0
1991	256	93092	678	69	609	10.18	36.36	2.65	0.73	0.07	1
1992	264	109513	716	68	648	9.50	41.48	2.71	0.65	0.06	0
1993	297	110413	623	78	545	12.52	37.18	2.10	0.56	0.07	0
1994	310	128182	640	83	557	12.97	41.35	2.06	0.50	0.06	0
1995	322	141929	674	98	576	14.54	44.08	2.09	0.47	0.07	0

2. District: Nicobar

1985											
1986	37	40073	2241	421	1820	18.79	108.31	60.57	5.59	1.05	0
1987	38	45609	2216	460	1756	20.76	120.02	58.32	4.86	1.01	0
1988	40	43884	2300	660	1640	28.70	109.71	57.50	5.24	1.50	1
1989	40	50474	1832	501	1331	27.35	126.19	45.80	3.63	0.99	0
1990	41	54634	1681	317	1364	18.86	133.25	41.00	3.08	0.58	0
1991	41	48730	1087	227	860	20.88	118.85	26.51	2.23	0.47	1
1992	42	51479	972	229	743	23.56	122.57	23.14	1.89	0.44	0
1993	47	51359	975	242	733	24.82	109.27	20.74	1.90	0.47	0
1994	49	55101	979	187	792	19.10	112.45	19.98	1.78	0.34	0
1995	54	66687	962	213	749	22.14	123.49	17.81	1.44	0.32	2

CHANDIGARH - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1995)

1. District : Chandigarh

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SFR	Deaths
1985											
1986	550	169457	30723	148	30575	0.48	30.81	55.86	18.13	0.09	0
1987	575	164714	19349	26	19323	0.13	28.65	33.65	11.75	0.02	0
1988	600	164311	14157	23	14134	0.16	27.39	23.60	8.62	0.01	0
1989	600	143482	15405	5	15400	0.03	23.91	25.68	10.74	0.00	0
1990	600	147004	26813	94	26719	0.35	24.50	44.69	18.24	0.06	0
1991	635	153646	26046	31	26015	0.12	24.20	41.02	16.95	0.02	0
1992	650	147436	17559	29	17530	0.17	22.68	27.01	11.91	0.02	0
1993	660	115697	9735	31	9704	0.32	17.53	14.75	8.41	0.03	0
1994	670	98233	7953	59	7894	0.74	14.66	11.87	8.10	0.06	0
1995	680	107697	9875	59	9816	0.60	15.84	14.52	9.17	0.05	0

DADRA & NARAG HAVELI - Districtwise & Yearwise Epidemological Data & Parameters (1985-1994)

1. District : Dadra & Nagar Haveli

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	104	15417	4150	161	3989	3.88	14.82	39.90	26.92	1.04	0
1987	104	21389	5625	270	5355	4.80	20.57	54.09	26.30	1.26	0
1988	104	25605	5845	350	5495	5.99	24.62	56.20	22.83	1.37	0
1989	104	22934	4741	69	4672	1.46	22.05	45.59	20.67	0.30	0
1990	104	23633	5015	191	4824	3.81	22.72	48.22	21.22	0.81	0
1991	138	28903	5101	363	4738	7.12	20.94	36.96	17.65	1.26	0
1992	138	44412	6676	787	5889	11.79	32.18	48.38	15.03	1.77	0
1993	138	47138	8121	869	7252	10.70	34.16	58.85	17.23	1.84	0
1994	138	41494	8571	1362	7209	15.89	30.07	62.11	20.66	3.28	0
1995	138	67450	15992	2195	13797	13.73	48.88	115.88	23.71	3.25	0

DELHI - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

1. District : Delhi (Delhi Urban)

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	6558	940472	23749	69	23680	0.29	14.23	3.59	2.52	0.00	0
1987	6608	723497	13066	11	13055	0.08	10.50	1.24	1.18	0.00	0
1988	7202	881940	12188	78	12110	0.63	12.24	0.01	1.38	0.00	0
1989	7345	710699	9978	28	9950	0.28	9.67	1.35	1.40	0.00	0
1990	7370	855459	11332	87	11245	0.76	11.60	1.53	1.32	0.01	0
1991	7480	822402	8049	20	8029	0.24	10.99	1.07	0.97	0.00	0
1992	8466	941763	10511	7676	10435	0.49	10.61	0.80	0.75	0.00	0
1993	8466	856667	7808	19	7787	0.27	9.92	0.57	0.57	0.00	0
1994	8653	867483	6838	47	6791	0.56	8.65	0.44	0.50	0.00	0
1995											

2. District : Delhi (Rural)

1985											
1986	1203	265357	2864	8	2856	0.28	22.06	2.38	1.08	0.00	0
1987	1212	201242	1046	11	1035	1.05	16.60	0.86	0.51	0.01	0
1988	1320	161776	2235	14	2221	0.02	12.25	1.69	1.38	0.00	0
1989	1347	174301	783	4	779	0.51	12.93	0.58	0.44	0.00	0
1990	1352	215093	646	2	644	0.30	15.90	0.47	0.30	0.00	0
1991	1372	168104	442	4	438	0.90	12.25	0.32	0.26	0.00	0
1992	1378	180587	708	14	694	13.39	0.61	0.46	0.02	0.00	0
1993	1459	174103	393	0	393	0.23	12.77	0.32	0.25	0.00	0
1994	1491	178294	391	0	391	0.00	16.76	0.39	0.23	0.00	0
1995											

DAMAN & DIU - Districtwise & Yearwise Epidemiological Data & Parameters (1985-1994)

1. District : Daman

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	Separated in 1986 from Goa										
1986	55	9445	291	1	290	0.34	17.17	5.29	3.08	0.01	0
1987	55	6276	325	0	325	0.00	11.41	5.91	5.18	0.00	0
1988											
1989	55	6649	554	0	554	0.00	12.09	10.07	8.33	0.00	0
1990	55	8804	648	0	648	0.00	16.00	11.78	7.36	0.00	0
1991											
1992	62	13577	917	24	893	2.62	21.90	14.79	6.75	0.18	0
1993	62	13059	1360	29	1331	2.13	21.06	21.94	10.41	0.22	0
1994	62	9922	1003	13	990	1.30	16.00	16.18	10.11	0.13	0
1995	73	23025	1393	124	1269	8.90	31.54	19.08	6.05	0.54	0

2. District : Diu

1985	Separated in 1986 from Goa										
1986	35	6848	103	18	85	17.48	19.57	2.94	1.50	0.26	0
1987	35	4848	59	0	59	0.00	13.85	1.69	1.22	0.00	0
1988											
1989	35	8626	230	46	184	20.00	24.64	6.57	2.67	0.53	0
1990	35	12629	153	55	98	35.94	36.08	4.37	1.21	0.44	0
1991											
1992	39	12832	282	62	220	21.99	32.90	7.23	2.20	0.48	0
1993	39	10982	205	16	189	7.80	28.16	5.26	1.87	0.15	0
1994	39	11423	233	35	198	15.02	29.29	5.97	2.04	0.31	0
1995	42	8598	169	12	157	7.10	20.47	4.02	1.97	0.14	0

LAKSHADWEEP - Districtwise & Yearwise Epidemological Data & Parameters (1985 - 1995)

1. District : U.T. of Lakshadweep

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985											
1986	44	1566	2	0	2	0.00	3.56	0.05	0.13	0.00	0
1987	45	879	3	0	3	0.00	1.95	0.07	0.34	0.00	0
1988	40	901	1	0	1	0.00	2.25	0.03	0.11	0.00	0
1989	40	2260	4	0	4	0.00	5.65	0.10	0.18	0.00	0
1990	50	1556	6	0	6	0.00	3.11	0.12	0.39	0.00	0
1991	52	2724	4	0	4	0.00	5.24	0.08	0.15	0.00	0
1992	52	2343	1	0	1	0.00	4.51	0.02	0.04	0.00	0
1993	52	4002	5	0	5	0.00	7.70	0.10	0.12	0.00	0
1994	52	2657	2	0	2	0.00	5.11	0.04	0.08	0.00	0
1995	53	2326	0	0	0	0.00	4.39	0.00	0.00	0.00	0

PONDICHERRY - Districtwise & Yearwise Epidemiogical Data & Parameters (1985-1995)

1. District : Pondicherry

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	444	158227	247	6	241	2.48	35.60	0.05	0.15	0.00	0
1986	478	139217	205	8	197	3.90	29.12	0.43	0.15	0.01	0
1987	478	142852	210	4	206	1.90	29.89	0.44	0.15	0.00	0
1988	535	131353	297	1	296	0.34	24.55	0.56	0.23	0.00	0
1989	535	134858	519	1	518	0.19	25.21	0.97	0.38	0.00	0
1990	535	132934	361	0	361	0.00	24.85	0.67	0.27	0.00	0
1991	535	172360	529	4	525	0.76	32.22	0.99	0.31	0.00	0
1992	598	176922	972	13	959	1.34	29.59	1.63	0.55	0.01	0
1993	598	168981	874	5	869	0.57	28.26	1.46	0.52	0.00	0
1994	814	212067	548	9	539	1.64	26.05	0.67	0.26	0.00	0
1995	916	204080	467	5	462	1.07	22.28	0.51	0.00	0.00	0

2. District : Karaikal

1985	120	51574	21	0	21	0.00	42.97	0.01	0.04	0.00	0
1986	126	53676	14	0	14	0.00	42.60	0.11	0.03	0.00	0
1987	126	52471	9	0	9	0.00	41.64	0.07	0.01	0.00	0
1988	145	48584	8	0	8	0.00	33.51	0.06	0.02	0.00	0
1989	145	60433	20	0	20	0.00	41.68	0.14	0.03	0.00	0
1990	145	62119	24	1	23	4.17	42.84	0.17	0.04	0.00	0
1991	145	54191	25	0	25	0.00	37.37	0.17	0.05	0.00	0
1992	162	56246	52	0	52	0.00	34.72	0.32	0.09	0.00	0
1993	162	56710	37	0	37	0.00	35.01	0.23	0.07	0.00	0
1994	162	54847	34	3	31	9.67	33.87	0.02	0.06	0.00	0

PONDICHERRY - Districtwise & Yearwise Epidemiogical Data & Parameters (1985-1995)

3. District : Mahe

Year	Pop. ('000 s)	BSE	Positives	*Pf*	*Pv*	*Pf* %	ABER	API	SPR	SfR	Deaths
1985	28	3886	5	0	5	0.00	13.67	0.01	0.12	0.00	0
1986	30	4271	5	0	5	0.00	14.24	0.17	0.12	0.00	0
1987	30	4839	1		1	0.00	16.13	0.03	0.02	0.00	0
1988	34	8491	4	0	4	0.00	24.97	0.12	0.05	0.00	0
1989	34	7397	2	0	2	0.00	21.76	0.06	0.03	0.00	0
1990	34	7485	4	0	4	0.00	22.01	0.12	0.05	0.00	0
1991	34	8180	9	0	9	0.00	24.06	0.26	0.11	0.00	0
1992	38	8920	9	0	9	0.00	23.47	0.24	0.10	0.00	0
1993	38	10137	3	0	3	0.00	26.68	0.08	0.03	0.00	0
1994											
1995											

4. District : Yanam

1985	12	1825	1	0	1	0.00	15.69	0.00	0.05	0.00	0
1986	12	2343	0	0	0	0.00	9.35	0.00	0.00	00.0	0
1987	13	2433	0	0	0	0.00	18.71	0.00	0.00	00.0	0
1988	14	2446	0	0	0	0.00	17.47	0.00	0.00	0.00	0
1989	14	3506	0	0	0	0.00	25.04	0.00	0.00	0.00	0
1990	14	3757	0	0	0	0.00	26.84	0.00	0.00	0.00	0
1991	14	4478	0	0	0	0.00	31.99	0.00	0.00	0.00	0
1992	16	4197	1	0	1	0.00	26.23	0.06	0.02	0.00	0
1993	16	4627	0	0	0	0.00	28.92	0.00	0.00	0.00	0
1994											

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

1. ANDHRA PRADESH

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	33390	1665813	1221682	8904	2986	33.53	3.66	0.27	0.73	0.24	0.09	-
1962	35260	2308365	2184074	12533	2656	21.19	6.19	0.36	0.57	0.12	0.08	-
1963	36517	3176793	3112124	13982	1744	12.47	8.52	0.38	0.45	0.06	0.05	-
1964	37001	4203176	4142610	11248	2583	22.96	11.20	0.30	0.27	0.06	0.07	-
1965	37765	3959009	3918661	9400	3073	32.69	10.38	0.25	0.24	0.08	0.08	-
1966	38612	4063721	4006811	4704	1466	31.16	10.38	0.12	0.12	0.04	0.04	-
1967	39090	3780283	3774764	2978	940	31.56	9.66	0.08	0.08	0.02	0.02	-
1968	39700	4548382	4492546	7658	2945	38.45	11.32	0.19	0.17	0.07	0.07	-
1969	40420	4256608	4253622	8765	3519	40.14	10.52	0.22	0.21	0.08	0.09	-
1970	41660	3974053	3951078	13334	3712	27.83	9.48	0.32	0.34	0.09	0.09	-
1971	41870	3319460	3222345	21652	4098	18.92	7.70	0.52	0.67	0.13	0.10	-
1972	42060	3963304	3803905	50482	4632	9.17	9.04	1.20	1.33	0.12	0.11	-
1973	42790	3376024	3189402	94400	6204	6.57	7.45	2.21	2.96	0.19	0.14	-
1974	43260	4160707	4135152	134295	13635	10.15	9.56	3.10	3.25	0.33	0.32	-
1975	43260	4614445	4577648	151103	13993	9.26	10.58	3.49	3.30	0.31	0.32	-
1976	43618	5552264	5413249	216154	19054	8.81	12.41	4.96	3.99	0.35	0.44	1
1977	43925	5757882	5757882	114620	11107	9.69	13.11	2.61	1.99	0.19	0.25	-
1978	44925	6847558	6847558	71723	9508	13.25	15.24	1.60	1.05	0.14	0.21	-
1979	45057	6712238	6712238	55575	10808	19.44	14.90	1.23	0.83	0.16	0.24	-
1980	45702	6977502	6977502	36204	10649	29.41	15.27	0.79	0.52	0.15	0.23	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	45970	7444057	7444051	38234	18202	47.60	16.19	0.83	0.51	0.24	0.40	-
1982	51945	6885858	6885858	34942	13198	37.77	13.26	0.67	0.51	0.19	0.25	-
1983	51945	6715391	6715391	35638	11694	32.81	12.93	0.69	0.53	0.17	0.23	-
1984	53593	6769753	6769753	46238	19124	41.35	12.63	0.86	0.68	0.28	0.36	-
1985	53607	7424093	7424093	36814	14202	38.58	13.85	0.69	0.50	0.19	0.26	1
1986	55225	5765055	5765055	28836	9931	34.44	10.44	0.52	0.50	0.17	0.18	1
1987	57566	7126821	7126821	53010	21743	41.02	12.38	0.92	0.74	0.31	0.38	1
1988	58012	7585643	7585643	62535	19677	31.47	13.08	1.08	0.82	0.26	0.34	1
1989	58691	7249159	7249159	82510	32815	39.77	12.35	1.41	1.14	0.45	0.56	2
1990	59405	7489681	7489681	104483	41224	39.46	12.61	1.76	1.40	0.55	0.69	5
1991	61091	7947338	7947338	82292	33390	40.58	13.01	1.35	1.04	0.42	0.55	2
1992	62266	8083152	8083152	80305	26594	33.12	12.98	1.29	0.99	0.33	0.43	0
1993	62266	8246869	8246714	86854	26703	30.74	13.24	1.39	1.05	0.32	0.42	7
1994	62756	8999993	8999993	90301	32227	35.68	14.34	1.44	1.00	0.36	0.51	9
1995(P)	62756	6923480	6923480	77547	28898	37.26	11.03	1.24	1.12	0.40	0.40	4

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

2. ARUNACHAL PRADESH

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	270		2671	277	9	3.24	0.99	1.03	10.37	0.34	0.03	0
1962	290	7000	7000	153	0	0.00	2.41	0.53	2.19	0.00	0.00	0
1963	302	15300	15300	1438	23	1.59	5.07	4.76	9.40	0.15	0.08	0
1964	320	15299	15299	1190	35	2.94	4.78	3.72	7.78	0.23	0.11	0
1965	335	10295	10295	801	64	7.99	3.07	2.39	7.78	0.62	0.19	0
1966	348	34958	34958	1008	63	6.25	10.05	2.90	2.88	0.18	0.18	0
1967	360	70889	64200	3644	961	26.37	17.83	10.12	5.68	1.50	2.67	0
1968	365	86532	77700	5816	1460	25.10	21.29	15.93	7.49	1.88	4.00	0
1969	370	95686	95576	10798	1821	16.86	25.83	29.18	11.30	1.91	4.92	0
1970	375	89057	88467	7461	1154	15.46	23.59	19.90	8.43	1.30	3.08	0
1971	385	9334	93549	11944	2759	23.09	24.30	31.02	12.77	2.95	7.17	0
1972	405	96821	96020	12269	1458	11.88	23.71	30.29	12.78	1.52	3.60	0
1973	455	56368	56368	10657	3479	32.64	12.39	23.42	18.91	6.17	7.65	0
1974	470	100642	99886	22271	7726	34.69	21.25	47.39	22.30	7.73	16.44	0
1975	470	105363	105363	24810	10328	41.62	22.42	52.79	23.55	9.80	21.97	4
1976	481	121487	121414	27934	10024	35.88	25.24	58.07	23.01	8.26	20.84	0
1977	490	122625	122625	24571	7156	29.12	25.03	50.14	20.04	5.84	14.60	9
1978	495	161263	161263	30127	10543	34.99	32.58	60.86	18.68	6.54	21.30	9
1979	500	201337	197031	35595	10036	28.19	39.41	71.19	18.07	5.09	20.07	14
1980	507	187193	187193	32166	8958	27.84	36.92	63.44	17.18	4.79	17.67	17

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	*%Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	554	209804	208901	33601	10029	29.84	37.71	60.65	16.08	4.80	18.10	6
1982	628	251440	251440	32148	6184	19.23	40.04	51.19	12.79	2.46	9.85	4
1983	629	226303	226303	31343	7745	24.71	35.98	49.83	13.85	3.42	12.31	1
1984	644	228437	228437	28234	6142	21.75	35.47	43.84	12.36	2.69	9.54	0
1985	681	236302	236302	24896	19475	78.23	34.70	36.56	10.54	8.24	28.60	1
1986	681	231985	231985	21810	4152	19.04	34.07	32.03	9.40	1.79	6.10	1
1987	688	219229	219229	16959	3516	20.73	31.86	24.65	7.74	1.60	5.11	0
1988	699	201588	201588	19254	3007	15.62	28.84	27.55	9.55	1.49	4.30	2
1989	725	206147	206147	20865	2725	13.06	28.43	28.78	10.12	1.32	3.76	0
1990	750	189899	189899	18227	2196	12.05	25.32	24.30	9.60	1.16	2.93	1
1991	755	189295	189295	18729	2985	15.94	25.07	24.81	9.89	1.58	3.95	0
1992	771	184001	184001	19113	3120	16.32	23.87	24.79	10.39	1.70	4.05	0
1993	837	225197	225197	29664	5072	17.10	26.91	35.44	13.17	2.25	6.06	0
1994	867	304046	304046	49703	9352	18.81	35.07	57.33	16.35	3.08	10.78	6
1995(P)	867	157660	157660	29551	4184	18.18	17.83	33.42	18.74	2.65	4.83	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

3. ASSAM

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	10250	131590	183768	2112	1289	61.03	1.79	0.21	1.15	0.70	0.13	0
1962	11215	393005	363477	3203	1475	46.05	3.24	0.29	0.88	0.41	0.13	0
1963	11608	612626	608562	10677	3174	29.72	5.24	0.92	1.75	0.52	0.27	0
1964	11988	978347	955234	11143	2191	19.66	7.97	0.93	1.17	0.23	0.18	0
1965	12160	1156997	1152427	10484	1811	17.27	9.48	0.86	0.91	0.16	0.15	0
1966	12862	1193334	1190590	12744	3327	26.10	9.26	0.99	1.07	0.28	0.99	0
1967	13550	1175016	1174708	17215	4709	27.35	8.67	1.27	1.47	0.40	0.35	0
1968	14060	1164567	1164214	21610	10536	48.75	8.28	1.54	1.86	0.90	0.75	0
1969	14680	1081865	1080774	27688	10772	38.90	7.36	1.89	2.56	1.00	0.73	0
1970	15000	894247	884434	17249	5226	30.29	5.90	1.15	1.95	0.59	0.35	0
1971	15200	943306	1009372	17434	5615	32.20	6.64	1.15	1.73	0.56	0.37	0
1972	15360	1085417	1000291	17246	5876	34.07	6.51	1.12	1.72	0.59	0.38	0
1973	15450	1089531	931917	37918	19759	52.10	6.03	2.45	4.07	2.12	1.28	0
1974	15700	1176450	1176450	58478	26126	44.67	7.49	3.72	4.97	2.22	1.66	0
1975	15700	1556074	1381628	126362	58795	46.52	8.80	8.05	9.15	4.26	3.74	68
1976	16058	1533850	1457561	148608	65177	43.85	9.08	9.25	10.20	4.47	4.06	44
1977	16492	1514054	1477008	96771	41212	42.58	8.96	5.87	6.55	2.79	2.50	35
1978	17218	1769403	1753694	80073	47203	58.94	10.19	4.65	4.57	2.69	2.74	30
1979	17671	1662956	1659238	73397	45015	61.33	9.89	4.15	4.42	2.71	2.55	58
1980	18179	1615875	1614419	65705	40758	62.03	8.88	3.61	4.07	2.52	2.24	47

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	19151	1775391	1775391	58106	34314	59.05	9.27	3.03	3.27	1.93	1.79	49
1982	19614	1793178	1793178	61799	37884	61.30	9.14	3.15	3.45	2.11	1.93	27
1983	20080	1534336	1534336	49237	32957	66.93	7.64	2.45	3.21	2.15	1.64	16
1984	20643	1887895	1887895	59678	38174	63.96	9.15	2.89	3.16	2.02	1.85	20
1985	20981	2145916	2145916	61978	41857	67.54	10.23	2.95	2.89	1.95	1.99	23
1986	21455	2650482	2619167	113135	80562	71.21	12.21	5.27	4.32	3.08	3.75	39
1987	21874	2182093	2182093	63858	38241	59.88	9.98	2.92	2.93	1.75	1.75	14
1988	22364	2147482	2147482	56296	35668	63.36	9.60	2.52	2.62	1.66	1.59	4
1989	22816	2172549	2172549	62274	39757	63.84	9.52	2.73	2.87	1.83	1.74	6
1990	23199	2076693	2076693	64871	38936	60.02		2.80	3.12	1.87	1.68	16
1991	23529	2412379	2412165	107572	72962	67.83	10.25	4.57	4.46	3.02	3.10	36
1992	23878	2343332	2343332	95168	62118	65.27	9.81	3.99	4.06	2.65	2.60	20
1993	24213	2684250	2684250	118403	78504	66.30	11.09	4.89	4.41	2.92	3.24	48
1994	24482	2750361	2750361	161038	105477	65.49	11.23	6.58	5.86	3.84	4.30	69
1995(P)	24482	2771160	2664596	208054	126244	60.67	10.88	8.50	7.81	4.74	5.15	300*

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

4. BIHAR

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	41425	1361144	1139812	3444	824	23.92	2.75	0.08	0.30	0.07	0.02	0
1962	43640	2189420	2020254	3505	1086	30.98	4.63	0.08	0.17	0.05	0.02	0
1963	46817	2873511	2863017	4556	1864	40.91	6.12	0.10	0.16	0.07	0.04	0
1964	49617	2802986	2783039	4647	1400	30.12	5.61	0.09	0.17	0.05	0.03	0
1965	50842	2646905	2605150	1513	220	14.54	5.12	0.03	0.06	0.01	0.00	0
1966	51690	2833917	2790895	1824	964	52.85	5.40	0.04	0.07	0.03	0.02	0
1967	53070	2675227	2619437	3111	1887	60.65	4.94	0.06	0.12	0.07	0.04	0
1968	53600	2859123	2581291	6007	4065	67.67	4.82	0.11	0.23	0.16	0.08	0
1969	54810	2629983	2566976	8057	4621	57.35	4.68	0.15	0.31	0.18	0.08	0
1970	54810	2571796	2506890	9876	5288	53.54	4.57	0.18	0.39	0.21	0.10	0
1971	55100	2027212	1997117	12447	7296	58.61	3.62	0.23	0.62	0.37	0.13	0
1972	56880	2167810	1902991	16701	8776	52.54	3.35	0.29	0.88	0.46	0.15	0
1973	58680	2150788	2028966	39989	21279	53.21	3.46	0.68	1.97	1.05	0.36	0
1974	59560	1431862	1042045	81903	22739	27.76	1.75	1.38	7.86	2.18	0.38	0
1975	59560	2037412	1878176	94371	48416	51.30	3.15	1.58	5.02	2.58	0.81	2
1976	59780	2227950	2014194	78048	40955	52.47	3.37	1.31	3.87	2.03	0.69	2
1977	60010	1937801	1925548	41097	20987	51.06	3.21	0.68	2.13	1.09	0.35	0
1978	61660	2541741	2541741	44787	16079	35.90	4.12	0.73	1.76	0.63	0.26	0
1979	62705	3155616	3110313	73457	36743	50.01	4.96	1.17	2.36	1.18	0.59	5
1980	67367	3214376	3184560	72094	38956	54.03	4.73	1.07	2.26	1.22	0.58	4

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	68922	3051974	3051974	64121	28383	44.26	4.43	0.93	2.10	0.93	0.41	5
1982	70296	2632516	2563380	49100	22608	46.04	3.65	0.70	1.92	0.88	0.32	7
1983	71683	2486629	2463605	47217	25922	54.89	3.44	0.66	1.92	1.05	0.36	6
1984	74069	2212096	2196908	51376	31621	61.54	2.97	0.69	2.34	1.44	0.43	11
1985	74694	2393540	2383850	48960	28149	57.49	3.19	0.66	2.05	1.18	0.38	19
1986	75786	2268186	2250906	42463	26298	61.93	2.97	0.56	1.89	1.17	0.35	19
1987	78520	2063768	2054552	32749	20245	61.82	2.62	0.42	1.59	0.99	0.26	11
1988	78621	1804539	1757750	29278	16136	55.11	2.24	0.37	1.67	0.92	0.21	4
1989	80092	1978295	1944007	50523	34136	67.57	2.43	0.63	2.60	1.76	0.43	13
1990	81734	1892242	1861290	57814	37898	65.55	2.28	0.71	3.11	2.04	0.46	7
1991	86345	1672568	1643393	60332	39220	65.01	1.90	0.70	3.67	2.39	0.45	14
1992	90105	1522942	1505136	65362	43191	66.08	1.67	0.73	4.34	2.87	0.48	21
1993	91295	1530599	1519203	75845	48652	64.15	1.66	0.83	4.99	3.20	0.53	2
1994	94682	1445096	1445096	71900	46367	64.48	1.53	0.76	4.98	3.21	0.48	12
1995(P)	94682	842555	804919	38499	20275	52.66	0.85	0.41	4.78	2.52	0.21	21

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1985 to 1995

5. GOA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1985	1199	97274	97274	80	3	3.75	8.11	0.07	0.08	0.00	0.00	0
1986	1263	73275	73275	433	2	0.46	5.80	0.34	0.59	0.00	0.00	0
1987	1263	108001	108001	4814	16	0.33	8.55	3.81	4.46	0.01	0.01	0
1988	1181	128955	128955	6732	287	4.26	10.92	5.70	5.22	0.22	0.24	0
1989	1181	102808	102808	4495	588	13.08	8.71	3.81	4.37	0.57	0.50	0
1990	1181	99687	99687	4890	871	17.81	8.44	4.14	4.91	0.87	0.74	1
1991	1181	85211	85211	2879	499	17.33	7.22	2.44	3.38	0.59	0.42	0
1992	1181	79094	79094	848	202	23.82	6.70	0.72	1.07	0.26	0.17	0
1993	1181	91439	91439	2227	333	14.95	7.74	1.89	2.44	0.36	0.28	0
1994	1181	101003	101003	3456	275	8.55	2.93	3.42	0.27	0.23	0.00	0
1995(P)	1181	88335	88335	3454	235	6.80	7.48	2.92	3.91	0.27	0.20	0

6. GUJARAT

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	18380	995816	933626	4044	1672	41.34	5.08	0.22	0.44	0.18	0.09	-
1962	20360	1366218	1415828	3286	933	28.39	6.95	0.16	0.23	0.07	0.05	-
1963	21027	2135404	2027593	10571	2430	22.98	9.64	0.50	0.52	0.12	0.12	-
1964	21718	2356849	2375334	21656	6658	30.74	10.94	1.00	0.91	0.28	0.31	-
1965	22005	2582860	2567585	15327	3746	24.44	11.67	0.70	0.60	0.15	0.17	-
1966	22640	3205349	3202042	17170	2561	14.91	14.14	0.76	0.54	0.08	0.11	-
1967	23150	4127055	4124784	79652	10295	12.92	17.82	3.44	1.93	0.25	0.44	-
1968	23750	3310828	3316224	56005	8391	14.98	13.96	2.36	1.69	0.25	0.35	-
1969	24390	3421755	3413417	91744	17751	19.34	14.00	0.73	2.69	0.52	0.73	-
1970	25070	3935277	3869857	269301	26969	10.01	15.44	10.74	6.96	0.70	1.08	-
1971	26240	4111301	4035868	583310	50133	8.59	15.38	22.23	14.45	1.24	1.91	-
1972	27050	5613484	4266522	524914	22148	4.21	15.77	19.41	12.30	0.52	0.82	-
1973	27860	4194857	4186862	437292	30846	7.05	15.03	15.70	10.44	0.74	1.11	-
1974	28920	4803200	4788440	573118	52019	9.07	16.56	19.82	11.97	1.09	1.80	-
1975	28920	5228864	5217271	799180	52189	6.53	18.04	27.63	15.32	1.00	1.80	-
1976	29280	5433512	5424384	1214028	73674	6.06	18.53	41.46	22.38	1.36	2.52	-
1977	29631	4349531	4343875	722687	33888	4.68	14.66	24.39	16.64	0.78	1.14	-
1978	30057	3651316	3651316	399254	10760	2.69	12.15	13.28	10.93	0.29	0.36	-
1979	31403	4195336	4193450	361119	11800	3.26	13.35	11.50	8.61	0.28	0.38	-
1980	32639	5065546	5064093	434770	17439	4.01	15.52	13.32	8.59	0.34	0.53	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	33961	4759690	4759690	414968	17342	4.17	14.02	12.22	8.72	0.36	0.51	-
1982	34587	4562468	4561540	332984	15177	4.55	13.19	9.63	7.30	0.33	0.44	-
1983	34986	4549981	4549361	280060	29913	10.68	13.00	8.00	6.16	0.66	0.85	-
1984	35758	4233474	4233050	253552	29473	11.62	11.84	7.09	5.99	0.70	0.82	-
1985	36331	3858300	3857925	139207	21952	15.77	10.62	3.83	3.61	0.57	0.60	-
1986	36470	4419658	4418721	153562	34903	22.73	12.12	4.21	3.48	0.79	0.96	-
1987	37333	5547129	5546844	274593	76158	27.73	14.86	7.36	4.95	1.37	2.04	4
1988	38272	6667004	6667004	460683	158552	34.42	1.20	12.04	6.90	34.42	4.14	67
1989	39027	6267887	6267887	598653	184137	30.76	1.53	15.34	9.55	30.76	4.72	60
1990	40000	6806732	6806732	515926	142391	27.60	1.29	12.90	7.57	27.60	3.56	84
1991	40918	6235933	6235933	404735	122235	30.20	0.99	9.89	6.49	30.20	2.99	37
1992	40918	6773846	6773846	348532	98213	28.18	0.88	8.79	5.14	28.18	2.48	28
1993	41634	6817570	6817570	304109	78051	25.67	0.73	7.30	4.46	25.67	1.87	25
1994	47264	6477534	6477534	242456	63494	26.18	13.71	5.13	3.74	9.98	1.34	14
1995(P)	47264	5841532	5810818	167476	34909	20.84	12.29	3.54	2.88	0.60	0.74	5

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1966 to 1995

7. HARYANA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1966	8120	843628	841308	155	4	2.58	10.36	0.02	0.02	0.00	0.00	0
1967	8340	1109983	1103718	2219	173	7.79	13.23	0.27	0.20	0.02	0.02	0
1968	8860	1131690	1129462	6610	12	0.18	12.75	0.75	0.59	0.00	0.00	0
1969	9100	1297769	1294669	8871	3	0.03	14.23	0.97	0.69	0.00	0.00	0
1970	9260	1234428	1234471	15897	60	0.37	13.33	1.72	1.29	0.00	0.01	0
1971	9470	1093124	1092216	24523	24	0.09	11.53	2.59	2.25	0.00	0.00	0
1972	9860	1261567	1262968	49126	28	0.05	12.81	4.98	3.89	0.00	0.00	0
1973	10680	1371697	1371697	109777	10	0.00	12.84	10.28	8.00	0.00	0.00	0
1974	10850	2246726	2246439	229869	258	0.11	20.70	21.19	10.23	0.01	0.02	0
1975	10850	2486156	2484901	507220	1823	0.35	22.90	46.75	20.41	0.07	0.17	0
1976	11400	3322378	3147996	736566	3755	0.50	27.61	64.61	23.40	0.12	0.33	0
1977	11848	3122009	3047329	639063	4334	0.67	25.72	53.94	20.97	0.14	0.37	2
1978	12646	3530975	3530975	708098	5969	0.84	27.92	55.99	20.05	0.17	0.47	1
1979	12800	3149578	3149578	436984	3771	0.86	24.61	34.14	13.87	0.12	0.29	1
1980	12866	3546364	3546364	294334	24893	8.45	27.56	22.88	8.30	0.70	1.93	1

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	12923	3413612	3412612	305690	32219	10.53	26.41	23.65	8.96	0.94	2.49	-
1982	14093	2964685	2964685	185447	20363	10.98	21.04	13.16	6.26	0.69	1.44	1
1983	14620	2822097	2822097	138600	23116	16.67	19.30	9.48	4.91	0.82	1.58	2
1984	14902	2719993	2719993	147160	18853	12.81	18.25	9.88	5.41	0.69	1.27	2
1985	15242	2542455	2542451	104020	9397	9.03	16.68	6.82	4.09	0.37	0.62	0
1986	15532	2592518	2592518	62575	2339	3.74	16.69	4.03	2.41	0.09	0.15	0
1987	15895	2533112	2533112	18926	289	1.53	15.94	1.19	0.75	0.01	0.02	0
1988	16322	2630028	2630028	9237	838	9.07	16.11	0.57	0.35	0.03	0.05	0
1989	16722	2474179	2474179	23711	678	2.86	14.80	1.42	0.96	0.03	0.04	0
1990	17091	2557524	2557524	50381	3617	7.18	14.96	2.95	1.97	0.14	0.21	0
1991	17593	2274879	2274879	34011	1142	3.36	12.93	1.93	1.50	0.05	0.06	0
1992	17906	2058650	2058650	16662	1238	7.43	11.50	0.93	0.81	0.06	0.07	1
1993	18039	2014650	2014650	22032	985	4.47	11.17	1.22	1.09	0.05	0.05	0
1994	18420	2202334	2202334	29810	3701	12.41	11.96	1.62	1.35	0.17	0.20	0
1995(P)	18420	2266023	2253297	54698	8222	12.23	11.99	2.97	2.43	0.36	0.45	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

8. HIMACHAL PRADESH

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	2288	25986	25242	16	0	0.00	1.10	0.01	0.06	0.00	0.00	
1962	2302	57872	57196	7	2	28.57	2.48	0.00	0.01	0.00	0.00	-
1963	2320	84759	87506	43	15	34.88	3.70	0.02	0.05	0.02	0.01	-
1964	2340	85129	83087	43	8	18.60	3.55	0.02	0.05	0.01	0.00	-
1965	2365	128668	128529	121	7	5.78	5.43	0.05	0.09	0.01	0.00	-
1966	2385	145220	135254	75	1	1.33	5.67	0.03	0.06	0.00	0.00	-
1967	2400	208058	202592	50	1	0.02	8.44	0.02	0.02	0.00	0.00	-
1968	2420	258113	266757	116	4	3.44	11.02	0.05	0.04	0.00	0.00	-
1969	2425	266631	237928	71	0	0.00	9.71	0.03	0.03	0.00	0.00	-
1970	2470	221999	199474	87	0	0.00	8.08	0.04	0.04	0.00	0.00	-
1971	2490	221134	211162	83	0	0.00	8.48	0.03	0.04	0.00	0.00	-
1972	2500	311783	266093	236	0	0.00	10.64	0.09	0.09	0.00	0.00	-
1973	2540	57898	57898	1092	3	0.27	2.28	0.43	1.89	0.01	0.00	-
1974	2580	319512	319031	8076	1	0.01	12.37	3.13	2.53	0.00	0.00	-
1975	2580	295757	295757	16481	3	0.01	11.46	6.39	5.57	0.00	0.00	-
1976	2600	272652	266826	22110	3	0.01	9.88	8.50	8.61	0.00	0.00	-
1977	2810	563825	463754	42184	6	0.01	16.50	15.01	9.10	0.00	0.00	-
1978	3183	631256	588649	49947	5	0.01	18.49	15.69	8.49	0.00	0.00	-
1979	3265	524978	514792	39870	10	0.02	15.77	12.21	7.74	0.00	0.00	-
1980	3352	676385	646449	49044	59	0.12	19.29	14.63	7.59	0.01	0.02	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	3420	842601	807589	81857	284	0.34	23.61	23.93	10.14	0.04	0.08	-
1982	3505	721960	681064	48708	125	0.25	19.43	13.90	7.15	0.02	0.04	-
1983	3540	719694	685598	38947	102	0.26	19.37	11.00	5.68	0.01	0.03	-
1984	3588	726479	680516	27966	790	2.82	18.97	7.79	4.11	0.12	0.22	-
1985	3658	745825	695375	36478	659	1.81	19.01	9.97	5.25	0.09	0.18	0
1986	3709	717344	684886	42136	324	0.77	18.47	11.36	6.15	0.05	0.09	0
1987	3795	711635	693320	22460	65	0.29	18.27	5.92	3.24	0.01	0.02	0
1988	3830	717691	701053	10209	39	0.38	18.30	2.67	1.46	0.01	0.01	0
1989	3921	716994	702247	8589	14	0.16	17.91	2.19	1.22	0.00	0.00	0
1990	4028	695304	681787	14379	29	0.20	16.93	3.57	2.11	0.00	0.01	0
1991	4098	732494	724531	20115	5	0.02	17.68	4.91	2.78	0.00	0.00	0
1992	4124	708111	703301	7251	9	0.12	17.05	1.76	1.03	0.00	0.00	0
1993	4288	668808	665928	4062	2	0.05	15.53	0.95	0.61	0.00	0.00	0
1994	4243	597549	597549	3091	6	0.19	14.08	0.73	0.52	0.00	0.00	0
1995(P)	4243	554450	542827	6534	10	0.15	12.79	1.54	1.20	0.00	0.00	0

9. JAMMU & KASHMIR

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	2040	3515	3515	10	0	0.00	0.17	0.00	0.28	0.00	0.00	0
1962	2070	35549	35549	5	2	0.40	1.72	0.00	0.01	0.01	0.00	0
1963	2118	70812	70812	2	0	0.00	3.34	0.00	0.00	0.00	0.00	0
1964	2148	95628	93125	7	0	0.00	4.34	0.00	0.01	0.00	0.00	0
1965	2178	120453	110906	8	0	0.00	5.09	0.00	0.01	0.00	0.00	0
1966	2198	162661	161395	5	0	0.00	7.34	0.00	0.00	0.00	0.00	0
1967	2200	60929	59653	29	0	0.00	2.71	0.01	0.05	0.00	0.00	0
1968	2225	77661	77661	1	0	0.00	3.49	0.00	0.00	0.00	0.00	0
1969	2250	95300	91047	1	0	0.00	4.05	0.00	0.00	0.00	0.00	0
1970	2300	129471	125614	0	0	0.00	5.46	0.00	0.00	0.00	0.00	0
1971	2340	60001	60139	4	0	0.00	2.57	0.00	0.01	0.00	0.00	0
1972	2375	65096	60182	34	3	8.82	2.53	0.01	0.06	0.00	0.00	0
1973	2400	70561	70561	1036	0	0.00	2.94	0.43	1.47	0.00	0.00	0
1974	2425	84463	69179	3618	3	0.08	2.85	1.49	5.23	0.00	0.00	0
1975	2425	185001	185001	19403	7	0.03	7.63	8.00	10.49	0.00	0.00	0
1976	2465	233895	223706	37839	9	0.02	9.08	15.35	16.91	0.00	0.00	0
1977	2500	339335	333720	37679	9	0.02	13.35	15.07	11.29	0.00	0.00	0
1978	2537	348592	348592	27376	10	0.03	13.74	10.79	7.85	0.00	0.00	0
1979	2539	351611	334919	11580	10	0.08	13.19	4.56	3.46	0.00	0.00	0
1980	2770	361448	356064	5423	19	0.35	12.85	1.96	1.52	0.01	0.01	0

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	2788	382910	377591	5703	16	0.28	13.54	2.05	1.51	0.00	0.01	0
1982	2895	399304	388546	7042	37	0.52	13.42	2.43	1.81	0.01	0.01	0
1983	2921	395951	387714	9901	165	1.66	13.27	3.39	2.55	0.04	0.06	0
1984	2964	399834	399834	18144	262	1.44	13.49	6.12	4.54	0.07	0.09	0
1985	3010	469730	459098	34026	1843	5.42	15.25	11.30	7.41	0.40	0.61	0
1986	3080	471032	466961	41815	2063	4.93	15.16	13.58	8.95	0.44	0.67	0
1987	3129	383072	377589	11540	206	1.79	12.07	3.69	3.06	0.05	0.07	0
1988	3184	386137	385828	4430	378	8.53	12.12	1.39	1.15	0.10	0.12	0
1989	3258	349318	350021	3062	101	3.30	10.74	0.94	0.87	0.03	0.03	0
1990	3336	373065	373016	5481	223	4.07	11.18	1.64	1.47	0.06	0.07	0
1991	3408	336868	336245	4656	11	0.24	9.87	1.37	1.38	0.00	0.00	0
1992	3646	278726	277383	1244	11	0.88	7.61	0.34	0.45	0.00	0.00	0
1993	3777	297303	295485	784	12	1.53	7.82	0.21	0.27	0.00	0.00	0
1994	3769	333625	333625	2760	48	1.73	8.85	0.73	0.83	0.01	0.01	0
1995(P)	3769	352067	346366	8893	34	0.38	9.19	2.36	2.57	0.01	0.01	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

10. KARNATAKA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	18965	1277972	1260910	3650	1011	27.69	6.65	0.19	0.29	0.08	0.05	
1962	22362	1639658	2023000	1335	531	39.77	9.05	0.06	0.07	0.03	0.02	-
1963	23987	2598546	2595539	646	315	48.76	10.82	0.03	0.02	0.01	0.01	-
1964	24540	2716178	2717764	789	251	31.81	11.07	0.03	0.03	0.01	0.01	-
1965	25000	2136581	2125495	1570	670	42.67	8.50	0.06	0.07	0.03	0.03	-
1966	25745	1970905	1969496	1182	707	59.81	7.65	0.05	0.06	0.04	0.03	-
1967	26500	2098282	2098078	858	345	40.20	7.92	0.03	0.04	0.02	0.01	-
1968	26882	2516978	2516588	1029	340	33.04	9.36	0.04	0.04	0.01	0.01	-
1969	27102	2672186	2642080	1408	308	21.87	9.75	0.05	0.05	0.01	0.01	-
1970	27680	2811432	2717578	2417	383	15.84	9.82	0.09	0.09	0.01	0.01	-
1971	27960	2772213	2691267	37725	836	2.21	9.63	1.35	1.40	0.03	0.03	-
1972	28200	3227309	3161686	41523	3181	7.66	11.21	1.47	1.31	0.10	0.11	-
1973	28690	2257658	2215994	78443	5481	6.98	7.72	2.73	3.54	0.25	0.19	-
1974	28950	2041409	2037943	173044	19637	11.34	7.04	5.98	8.49	0.96	0.68	-
1975	28950	3307445	3255901	330963	34658	10.47	11.25	11.43	10.17	1.06	1.20	1
1976	29313	3691080	3450331	634517	69900	11.01	11.77	21.64	18.39	2.03	2.38	-
1977	29670	4296234	3977342	536404	42317	7.88	13.41	18.08	13.49	1.06	1.43	-
1978	30540	4114729	3408158	318890	14574	4.57	11.16	10.44	9.36	0.43	0.48	-
1979	31385	4283457	4108543	276832	12473	4.50	13.09	8.82	6.74	0.30	0.40	-
1980	32233	4722433	4490829	224634	7626	3.39	13.93	6.97	5.00	0.17	0.24	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	33121	5280464	5280464	158528	10336	6.51	15.94	4.79	3.00	0.20	0.31	-
1982	34947	5198148	5198148	102299	3845	3.75	14.87	2.93	1.97	0.07	0.11	-
1983	37152	5485241	5485230	61982	3375	5.44	14.76	1.67	1.13	0.06	0.09	-
1984	37152	5266455	5266455	32293	3337	10.33	14.18	0.87	0.61	0.06	0.09	-
1985	36689	5293393	5283545	39237	9630	24.54	14.40	1.07	0.74	0.18	0.26	0
1986	37842	5754370	5754370	58119	16906	29.09	15.21	1.54	1.01	0.29	0.45	0
1987	38740	6392129	6392110	88505	29582	33.42	16.50	2.28	1.38	0.46	0.76	0
1988	38740	6866873	6854873	127008	37464	29.50	17.69	3.28	1.85	0.55	0.97	8
1989	38740	6681678	6681678	106683	29410	27.57	17.25	2.75	1.60	0.44	0.76	0
1990	38740	6601484	6601484	74012	22976	31.04	17.04	1.91	1.12	0.35	0.59	0
1991	38740	6646213	6646213	44565	9875	22.16	17.16	1.15	0.67	0.15	0.25	8
1992	38936	6913592	6913592	81057	16578	20.45	17.76	2.08	1.17	0.24	0.43	0
1993	39868	7098519	7098519	196466	48484	24.68	17.81	4.93	2.77	0.68	1.22	0
1994	40175	7110830	7110830	266459	37789	14.18	17.70	6.63	3.75	0.53	0.94	3
1995(P)	40175	5580299	5580299	234835	29046	12.36	13.89	5.85	4.21	0.52	0.72	20

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

11. KERALA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	14445	481602	421235	111	34	30.63	2.92	0.01	0.03	0.01	0.00	
1962	15265	1009353	1044118	65	4	6.15	6.84	0.00	0.01	0.00	0.00	-
1963	15920	1562605	1542451	55	5	9.09	9.69	0.00	0.00	0.00	0.00	-
1964	16713	561977	558208	33	2	6.06	3.34	0.00	0.01	0.00	0.00	-
1965	17024	760624	730128	67	0	0.00	4.29	0.00	0.01	0.00	0.00	-
1966	17864	963173	942943	124	2	1.61	5.28	0.01	0.01	0.00	0.00	-
1967	18940	905367	877874	143	0	0.00	4.64	0.01	0.02	0.00	0.00	-
1968	19350	873506	853417	135	2	1.48	4.41	0.01	0.02	0.00	0.00	-
1969	19830	767189	742102	202	2	0.99	3.74	0.01	0.03	0.00	0.00	-
1970	20000	745211	700056	279	11	3.94	3.50	0.01	0.04	0.00	0.00	-
1971	20150	711846	722401	287	2	0.69	3.59	0.01	0.04	0.00	0.00	-
1972	20650	683738	630820	404	2	0.49	3.05	0.02	0.06	0.00	0.00	-
1973	21360	555667	555667	666	8	1.20	2.60	0.03	0.12	0.00	0.00	-
1974	21830	694123	674453	862	8	0.92	3.09	0.04	0.13	0.00	0.00	-
1975	21830	529760	529760	1651	23	1.39	2.43	0.08	0.31	0.00	0.00	-
1976	22028	936097	880069	5029	38	0.75	4.00	0.23	0.57	0.00	0.00	-
1977	22548	1086752	996340	5468	27	0.49	4.42	0.24	0.55	0.00	0.00	-
1978	22840	929727	929727	6196	23	0.37	4.07	0.27	0.67	0.00	0.00	-
1979	23000	695168	676534	3972	17	0.42	2.94	0.17	0.59	0.00	0.00	-
1980	23334	629227	571087	3339	44	1.31	2.45	0.14	0.58	0.01	0.00	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	25391	855700	756805	4127	26	0.62	2.98	0.16	0.55	0.00	0.00	-
1982	25454	812116	747344	3981	27	0.67	2.94	0.16	0.53	0.00	0.00	-
1983	26441	889120	791590	3725	80	2.14	2.99	0.14	0.47	0.01	0.00	-
1984	26932	905910	811288	4735	45	0.95	3.01	0.18	0.58	0.01	0.00	-
1985	26932	690467	641410	3854	47	1.22	2.38	0.14	0.60	0.01	0.00	1
1986	26932	844019	810256	3382	87	2.57	3.01	0.13	0.42	0.01	0.00	1
1987	26932	1179102	1138073	3772	112	2.97	4.23	0.14	0.33	0.01	0.00	1
1988	27690	1462769	1421729	5147	112	2.18	5.13	0.19	0.36	0.01	0.00	1
1989	28225	1640347	1588007	6126	157	2.56	5.63	0.22	0.39	0.01	0.01	1
1990	28750	1703542	1667642	6411	153	2.39	5.80	0.22	0.38	0.01	0.01	1
1991	29270	1574910	1543334	6758	186	2.75	5.27	0.23	0.44	0.01	0.01	0
1992	29895	1404382	1373497	8255	224	2.71	4.59	0.28	0.60	0.02	0.01	2
1993	29093	1266410	1244421	9277	238	2.57	4.28	0.32	0.75	0.02	0.01	0
1994	30357	979762	979762	9075	272	2.99	3.23	0.30	0.93	0.03	0.08	1
1995(P)	30357	801905	796489	7856	344	4.37	2.62	0.26	0.99	0.04	0.01	2

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA .- 1961 to 1995

12. MADHYA PRADESH

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	*%Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	28262	817806	730763	1180	575	48.72	2.59	0.04	0.16	0.08	0.02	-
1962	30672	1424861	1332696	8609	3087	35.85	4.34	0.28	0.65	0.23	0.10	-
1963	31917	2894728	2587126	8920	3787	42.45	8.11	0.28	0.34	0.15	0.12	-
1964	33975	2938843	2815498	13781	6408	46.49	8.29	0.41	0.49	0.23	0.19	-
1965	34447	2886985	2880953	20157	5691	28.23	8.36	0.59	0.70	0.20	0.17	-
1966	35068	3595396	3554757	62357	15688	25.15	10.14	1.78	1.75	0.44	0.45	-
1967	36280	3601197	3525538	84569	16752	19.80	9.72	2.33	2.40	0.48	0.46	-
1968	37400	3245550	3221573	66460	24792	37.30	8.61	1.78	2.06	0.77	0.66	-
1969	38780	3139558	3137474	57786	19510	33.76	8.09	1.49	1.84	0.62	0.50	-
1970	40720	3873059	3728309	136108	22641	16.63	9.16	3.34	3.65	0.61	0.56	-
1971	41045	4158988	3860105	191236	29483	15.41	9.40	4.66	4.95	0.76	0.72	-
1972	42380	4321568	4171495	215264	34106	15.84	9.84	5.08	5.16	0.82	0.80	-
1973	43600	5338854	4429573	276910	44567	16.09	10.16	6.35	6.25	1.01	1.02	-
1974	44520	4367319	4316526	477058	104022	21.80	9.70	10.72	11.05	2.41	2.34	-
1975	44520	4845438	4798292	836680	228192	27.27	10.78	18.79	17.44	4.76	5.13	-
1976	45019	4574848	4485107	878693	155759	17.72	9.96	19.52	19.59	3.47	3.46	-
1977	46120	4589252	4572652	365077	80923	22.16	9.91	7.92	7.98	1.77	1.75	-
1978	47128	4882552	4752507	261740	70848	27.06	10.08	5.55	5.51	1.49	1.50	1
1979	48530	5772141	5748841	270819	88061	32.51	11.85	5.58	4.71	1.53	1.81	2
1980	49770	7046630	6964723	391364	104056	26.58	13.99	7.86	5.62	1.49	2.09	25

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	52132	5977858	5977451	337508	94021	27.85	11.47	6.47	5.65	1.57	1.80	16
1982	53779	5717031	5717031	228982	70915	30.96	10.63	4.26	4.01	1.24	1.32	28
1983	54770	5571071	5571071	171585	78981	46.03	10.17	3.13	3.08	1.42	1.44	13
1984	56137	5233500	5233500	145712	77332	53.07	9.32	2.60	2.78	1.48	1.38	12
1985	59807	5270533	5261254	111631	54970	49.24	8.80	1.87	2.12	1.04	0.92	3
1986	59189	5543997	5543997	165592	90688	54.77	9.37	2.80	2.99	1.64	1.53	10
1987	60669	6702891	6702341	303033	142825	47.13	11.05	4.99	4.52	2.13	2.35	13
1988	62180	7620570	7620570	306882	139379	45.42	12.26	4.94	4.03	1.83	2.24	8
1989	63735	7176101	7176101	252886	104811	41.45	11.26	3.97	3.52	1.46	1.64	16
1990	65421	6823296	6823296	224502	109197	48.64	10.43	3.43	3.29	1.60	1.67	3
1991	66136	6915958	6911825	282681	165428	58.52	10.45	4.27	4.09	2.39	2.50	28
1992	67789	7197837	7197837	269930	153499	56.87	10.62	3.98	3.75	2.13	2.26	39
1993	69446	7522941	7522941	283600	150097	52.93	10.83	4.08	3.77	2.00	2.16	12
1994	69446	7817061	7817061	323628	151440	46.79	11.56	4.79	4.14	1.94	2.23	28
1995(P)	67621	6625905	6129111	300959	114724	38.11	9.06	4.45	4.91	1.87	1.70	19

13. MAHARASHTRA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	34490	2052281	1088857	3641	1932	53.06	3.16	0.11	0.33	0.18	0.06	-
1962	37492	3061037	2924926	4496	1653	36.76	7.80	0.12	0.15	0.06	0.04	-
1963	39348	4515829	4382614	3570	1773	49.66	11.14	0.09	0.08	0.04	0.05	-
1964	41860	4874661	4839851	4998	2492	49.85	11.56	0.12	0.10	0.05	0.06	-
1965	42718	4386940	4276081	6095	2285	37.48	10.01	0.14	0.14	0.05	0.05	-
1966	43670	4975450	4872488	12890	5167	40.08	11.16	0.30	0.26	0.11	0.12	-
1967	44640	5470553	5369060	19410	6148	31.67	12.03	0.43	0.36	0.11	0.14	-
1968	46060	6047295	5987393	26785	7901	29.49	13.00	0.58	0.45	0.13	0.17	-
1969	47620	6338685	6245396	60350	16702	27.67	13.12	1.27	0.97	0.27	0.35	-
1970	49825	6072505	5994301	91319	18065	19.78	12.03	1.83	1.52	0.30	0.36	-
1971	50565	6081980	6079174	199096	22108	11.10	12.02	3.94	3.28	0.36	0.44	-
1972	51840	6711675	6711675	223289	21388	9.57	12.95	4.31	3.33	0.32	0.41	-
1973	52540	7487755	7486120	262780	18122	6.89	14.25	5.00	3.51	0.24	0.34	-
1974	53390	7398410	7398410	428432	38919	9.08	13.86	8.02	5.79	0.53	0.73	-
1975	53590	7589528	7399052	705472	55972	7.93	13.81	13.16	9.53	0.76	1.04	1
1976	54095	7860174	7816956	702155	39055	5.56	14.45	12.98	8.98	0.50	0.72	1
1977	55567	6816527	6816527	340071	26926	7.91	12.27	6.12	4.99	0.40	0.48	-
1978	58979	5920383	5920383	215733	34218	15.86	10.04	3.66	3.64	0.58	0.58	1
1979	61700	6043184	6036680	204596	38120	18.63	9.78	3.32	3.39	0.63	0.62	-
1980	62728	6209204	6209204	191911	30291	15.78	9.90	3.06	3.09	0.49	0.48	5

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	62915	6254348	6254348	110552	16575	14.99	9.94	1.76	1.77	0.27	0.26	-
1982	63995	7501655	7501655	84814	15803	18.63	11.72	1.33	1.13	0.21	0.25	5
1983	64720	7569077	7569077	82983	13692	16.49	11.70	1.28	1.10	0.18	0.21	1
1984	67970	8241301	8241301	91949	16621	18.07	12.12	1.35	1.12	0.20	0.24	-
1985	69462	8415245	8415245	61825	13397	21.67	12.11	0.89	0.73	0.16	0.19	2
1986	71269	8378660	8378660	47998	12957	26.99	11.76	0.67	0.57	0.15	0.18	6
1987	72560	9321213	9321213	60557	23430	38.69	12.85	0.83	0.65	0.25	0.32	2
1988	72723	9228866	9228866	84030	26952	32.07	12.69	1.16	0.91	0.29	0.37	5
1989	73804	9381938	9381938	122314	37724	30.84	12.71	1.66	1.30	0.40	0.51	8
1990	74644	9636193	9636193	113266	36596	32.31	12.91	1.52	1.18	0.38	0.49	6
1991	77626	9363327	9363327	145310	53793	37.02	12.06	1.87	1.55	0.57	0.69	15
1992	81458	10375206	10375206	203812	61104	29.98	12.74	2.50	1.96	0.59	0.75	2
1993	83487	10491235	10491235	252475	71529	28.33	12.57	3.02	2.41	0.68	0.86	15
1994	98105	13109041	13109041	330699	103616	31.33	13.36	3.37	2.52	0.79	0.03	9
1995(P)	98105	11300293	11163896	328655	111175	33.82	11.38	3.35	2.94	1.00	1.13	219

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

14. MANIPUR

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	765	26582	26582	95	47	49.47	3.47	0.12	0.36	0.18	0.06	-
1962	825	46433	46163	54	17	31.48	5.60	0.07	0.12	0.04	0.02	-
1963	890	69756	69756	102	26	25.49	7.84	0.11	0.15	0.04	0.03	-
1964	896	101585	101523	93	39	41.93	11.33	0.10	0.09	0.04	0.04	-
1965	900	120554	120493	270	75	27.77	13.39	0.30	0.22	0.06	0.08	-
1966	904	108762	108076	409	140	34.22	11.96	0.45	0.38	0.13	0.15	-
1967	920	105391	105215	173	43	24.85	11.44	0.19	0.16	0.04	0.05	-
1968	940	108890	108867	460	195	42.39	11.58	0.49	0.42	0.18	0.21	-
1969	970	105030	105030	579	133	22.97	10.83	0.60	0.55	0.13	0.14	-
1970	1000	106286	106276	498	56	11.24	10.63	0.50	0.47	0.05	0.06	-
1971	1040	84156	83059	310	37	11.93	7.99	0.30	0.37	0.04	0.04	-
1972	1120	100431	100307	843	230	27.28	8.96	0.75	0.84	0.23	0.21	-
1973	1160	70476	70476	2147	823	38.33	6.08	1.85	3.05	1.17	0.71	-
1974	1180	111507	111507	1342	446	33.23	9.45	1.14	1.20	0.40	0.38	-
1975	1180	115065	115065	2162	628	29.04	9.75	1.83	1.88	0.55	0.53	-
1976	1182	112023	105988	1208	530	43.87	8.97	1.02	1.14	0.50	0.45	-
1977	1218	69922	69922	1082	488	45.10	5.74	0.89	1.55	0.70	0.40	-
1978	1349	130855	130855	3655	2402	65.71	9.70	2.71	2.79	1.84	1.78	4
1979	1389	125499	125367	4234	2474	58.43	9.03	3.05	3.38	1.97	1.78	-
1980	1394	116299	116299	2646	1017	38.43	8.34	1.90	2.28	0.87	0.73	3

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	1431	124788	124788	1255	536	42.70	8.72	0.88	1.01	0.43	0.37	2
1982	1433	126590	126590	2342	1717	73.31	8.83	1.63	1.85	1.36	1.20	5
1983	1564	119446	119446	1553	1019	65.61	7.64	0.99	1.30	0.85	0.65	1
1984	1574	157977	157977	1284	804	62.61	10.04	0.82	0.81	0.51	0.51	-
1985	1574	163618	163618	1166	690	59.18	10.40	0.74	0.71	0.42	0.44	1
1986	1620	188065	188065	1778	904	50.84	11.61	1.10	0.95	0.48	0.56	4
1987	1667	171314	171314	1084	353	32.56	10.28	0.65	0.63	0.21	0.21	0
1988	1685	186790	186790	1076	438	40.71	11.09	0.64	0.58	0.23	0.26	2
1989	1696	195644	195644	957	397	41.48	11.54	0.56	0.49	0.20	0.23	2
1990	1729	194568	194568	601	275	45.76	11.25	0.35	0.31	0.14	0.16	0
1991	1826	194150	194150	640	325	50.78	10.63	0.35	0.33	0.17	0.18	0
1992	1866	194739	194739	2119	916	43.23	10.44	1.14	1.09	0.47	0.49	9
1993	1866	186236	186236	1896	781	41.19	9.98	1.02	1.02	0.42	0.42	9
1994	1921	169767	169767	7845	5314	67.73	8.84	4.08	4.62	3.13	1.04	55
1995(P)	1921	119003	119003	4256	1997	46.92	6.19	2.12	3.58	1.68	1.04	17

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1970 to 1995

15. MEGHALAYA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1970	-	81246	81246	4556	3059	67.14	5.61	3.77	-			
1971	-	103972	103972	2751	1716	62.37	2.65	1.65	-			
1972	1020	82641	79398	2934	1836	62.57	7.78	2.88	3.70	2.31	1.80	0
1973	1050	109907	98777	6393	4810	75.23	9.41	6.09	6.47	4.87	4.58	0
1974	1070	98011	98011	4107	2412	58.72	9.16	3.84	4.19	2.46	2.25	0
1975	1070	100416	100416	6763	2969	43.90	9.38	6.32	6.73	2.96	2.77	0
1976	1105	108869	101788	7035	4804	68.28	9.21	6.37	6.91	4.72	4.35	0
1977	1110	133275	133275	9812	7966	81.18	12.01	8.84	7.36	5.98	7.18	0
1978	1115	152869	152869	9974	8205	82.26	13.71	8.95	6.52	5.37	7.36	0
1979	1192	196026	196026	17342	14570	84.01	16.45	14.55	8.85	7.43	12.22	8
1980	1211	216901	216901	19010	16401	86.27	17.91	15.70	8.76	7.56	13.54	12
1981	1317	222977	190839	12640	10204	80.72	14.49	9.60	6.62	5.35	7.75	1
1982	1331	216905	216905	16710	13605	81.41	16.30	12.55	7.70	6.27	10.22	5
1983	1410	178646	178646	11600	8961	77.25	12.67	8.23	6.49	5.02	6.36	1
1984	1464	209416	209416	15315	12403	80.98	14.30	10.46	7.31	5.92	8.47	0
1985	1515	209389	209389	12560	9681	77.08	13.82	8.29	6.00	4.62	6.39	0
1986	1530	233137	233137	14687	11618	79.10	15.24	9.60	6.30	4.98	7.59	1
1987	1582	197944	197944	10975	7997	72.87	12.51	6.94	5.54	4.04	5.05	1
1988	1604	199797	199797	11863	8748	73.74	12.46	7.40	5.94	4.38	5.45	0

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1989	1654	196898	196898	10701	7767	72.58	11.90	6.47	5.43	3.94	4.70	0
1990	1731	147756	147756	8209	5691	69.33	8.54	4.74	5.56	3.85	3.29	0
1991	1778	208872	208872	11155	7433	66.63	11.75	6.27	5.34	3.56	4.18	0
1992	1808	206909	206909	11283	6863	60.83	11.44	6.24	5.45	3.32	3.80	0
1993	1882	178464	178464	10045	4999	49.77	9.48	5.34	5.63	2.80	2.66	0
1994	1923	202105	202105	11953	7712	64.51	10.51	6.22	5.91	3.82	4.01	11
1995(P)	1923	158613	158613	10533	6997	66.42	8.25	5.48	6.64	4.41	3.64	18

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1971 to 1995

16. MIZORAM

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1971	-	24643	24643	3436	416	12.10	13.94	1.69	-			
1972	400	18531	18531	2573	567	22.03	4.63	6.43	13.88	3.06	1.42	-
1973	410	46206	46206	8640	5045	58.39	11.27	21.07	18.70	10.92	12.30	-
1974	420	36035	36035	6912	3833	55.45	8.58	16.46	19.18	10.64	9.13	-
1975	430	55584	55584	13179	7301	55.39	12.93	30.65	23.71	13.14	16.98	15
1976	430	55824	55824	11941	4781	40.03	12.98	27.77	21.39	8.56	11.12	1
1977	442	39261	39261	5490	1889	34.40	8.88	12.42	13.98	4.81	4.27	1
1978	447	96927	96927	12361	8229	66.57	21.68	27.65	12.75	8.49	18.41	-
1979	450	165066	165066	19345	12075	62.41	36.68	42.99	11.72	7.32	26.83	3
1980	458	174289	174289	19779	10237	51.75	38.05	43.19	11.35	5.87	22.35	-
1981	488	167454	167418	17361	11521	66.36	34.31	35.58	10.37	6.88	23.61	4
1982	487	226199	226199	24677	13282	53.82	46.45	50.67	10.91	5.87	27.27	8
1983	503	172106	172106	14991	7551	50.37	34.22	29.80	8.71	4.39	15.01	5
1984	503	168147	168147	15056	8129	53.99	33.43	29.93	8.95	4.83	16.16	6
1985	520	193102	193102	16217	8338	51.42	37.14	31.19	8.40	4.32	16.03	5
1986	544	210219	210219	19116	10155	53.12	38.64	35.14	9.09	4.83	18.67	34
1987	556	191186	191186	15356	8048	52.41	34.39	27.62	8.03	4.21	14.47	28
1988	575	205520	205520	20339	9025	44.37	35.74	35.37	9.90	4.39	15.70	16
1989	603	232046	232046	18517	9208	49.73	38.48	30.71	7.98	3.97	15.27	17

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1990	618	175816	175816	13823	6148	44.48	28.45	22.37	7.86	3.50	9.95	8
1991	655	186713	186713	12486	5798	46.44	28.51	19.06	6.69	3.11	8.85	12
1992	670	259580	259580	20592	11364	55.19	38.74	30.73	7.93	4.38	16.96	36
1993	675	214359	214359	13166	6544	49.70	31.76	19.51	6.14	3.05	9.69	33
1994	710	204993	204993	13998	7327	52.34	28.87	19.72	6.83	3.57	14.49	41
1995(P)	710	257877	257877	16776	10252	61.11	36.32	23.63	6.51	3.98	14.44	49

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

17. NAGALAND

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	340	1950	1950	17	4	23.52	0.57	0.05	0.87	0.21	0.01	0
1962	360	0	0	0	0	0	0	0	0	0	0	0
1963	385	0	0	0	0	0	0	0	0	0	0	0
1964	389	141	141	0	0	0.04	0.00	0.00	0.00	0.00	0	0
1965	393	3401	3401	26	0	0.00	0.87	0.07	0.76	0.00	0.00	0
1966	398	7168	7168	409	165	40.34	1.80	1.03	5.71	2.30	0.41	0
1967	400	8053	8063	266	28	10.52	2.02	0.67	3.30	0.35	0.07	0
1968	410	12327	12327	325	79	24.30	3.01	0.79	2.64	0.64	0.19	0
1969	420	16018	16018	822	315	38.32	3.81	1.96	5.13	1.97	0.75	0
1970	430	19633	19633	602	173	28.73	4.57	1.40	3.07	0.88	0.40	0
1971	440	19836	19816	435	86	19.77	4.50	0.99	2.20	0.43	0.20	0
1972	490	23785	23785	875	268	30.62	4.85	1.79	3.68	1.13	0.55	0
1973	510	25258	25258	2823	1846	65.39	4.95	5.54	11.18	7.31	3.62	0
1974	520	30028	30028	3108	2018	64.92	5.77	5.98	10.35	6.72	3.88	0
1975	520	38090	38090	5344	3425	64.09	7.33	10.28	14.03	8.99	6.59	3
1976	580	30195	30195	1609	961	59.72	5.21	2.77	5.33	3.18	1.66	0
1977	640	35089	34997	3805	2305	60.57	5.47	5.95	10.87	6.59	3.60	0
1978	708	67141	67141	8424	4962	58.90	9.48	11.90	12.55	7.39	7.01	0
1979	740	84646	84646	12019	7552	62.83	11.44	16.24	14.20	8.92	10.21	17
1980	755	78110	78011	9733	4806	49.37	10.33	12.89	12.48	6.16	6.37	4

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	867	64253	64253	7401	3563	48.14	7.41	8.54	11.52	5.55	4.11	2
1982	867	65407	65407	6814	3056	44.84	7.54	7.86	10.42	4.67	3.52	0
1983	871	57775	57775	4595	1652	35.95	6.63	5.28	7.95	2.86	1.90	0
1984	995	52289	52289	5322	1721	32.33	5.26	5.35	10.18	3.29	1.73	0
1985	1006	59548	59548	5163	1377	26.67	5.92	5.13	8.67	2.31	1.37	0
1986	1006	58810	58810	6317	2022	32.01	5.85	6.28	10.74	3.44	2.01	1
1987	1006	49951	49951	5000	1563	31.26	4.97	4.97	10.01	3.13	1.55	0
1988	1012	50763	50763	3744	954	25.48	5.02	3.70	7.38	1.88	0.94	0
1989	1015	43907	43907	3051	843	27.63	4.33	3.01	6.95	1.92	0.83	0
1990	1043	37299	37299	2406	570	23.69	3.58	2.31	6.45	1.53	0.55	0
1991	1215	39626	39626	2422	533	22.01	3.26	1.99	6.11	1.35	0.44	0
1992	1208	33634	33634	2218	432	19.48	2.78	1.84	6.59	1.28	0.36	0
1993	1275	26955	26955	1584	284	17.93	2.11	1.24	5.88	1.05	0.22	0
1994	1294	64429	64429	2292	944	41.18	4.98	1.77	3.56	1.47	0.72	253
1995(P)	1294	39751	39751	2607	548	21.02	3.07	2.01	6.56	1.38	0.42	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

18. ORISSA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	13600	535329	356203	5052	676	13.38	2.62	0.37	1.42	0.19	0.05	
1962	14762	941230	553892	11758	2960	25.17	3.75	0.80	2.12	0.53	0.20	-
1963	16065	1197581	732089	17376	4006	23.05	4.56	1.08	2.37	0.55	0.25	-
1964	17082	1805214	1641723	31796	6939	21.82	9.61	1.86	1.94	0.42	0.41	-
1965	17862	1991412	1909032	24992	7466	29.87	10.69	1.40	1.31	0.39	0.42	-
1966	18675	2373699	2276060	9949	7142	71.78	12.19	0.53	0.44	0.31	0.38	-
1967	19230	2286182	2240144	18561	15449	83.23	11.65	0.97	0.83	0.69	0.80	-
1968	19650	2390680	2374084	31794	24854	78.17	12.08	1.62	1.34	1.05	1.26	-
1969	20300	2144396	2130767	28962	22379	77.27	10.50	1.43	1.36	1.05	1.10	-
1970	20900	1464962	974439	11338	5346	47.15	4.66	0.54	1.16	0.55	0.26	-
1971	21650	1626715	1262293	33260	13562	40.77	5.83	1.54	2.63	1.07	0.63	-
1972	22620	1847032	928212	51226	23458	45.79	4.10	2.26	5.52	2.53	1.04	-
1973	23180	2526946	1956863	189767	79379	41.82	8.44	8.19	9.70	4.06	3.42	-
1974	23550	2492688	2002802	297701	154665	51.95	8.50	12.64	14.86	7.72	6.57	-
1975	23550	2605284	2132313	317669	147760	46.51	9.05	13.49	14.90	6.93	6.27	1
1976	23953	3018480	2074165	329104	210227	63.87	8.66	13.74	15.87	10.14	8.78	-
1977	24360	2940555	1872678	212337	136977	64.50	7.69	8.72	11.34	7.31	5.62	-
1978	24715	3225186	2678697	374591	270245	72.14	10.84	15.16	13.98	10.09	10.93	-
1979	24715	3034823	2786157	310952	225582	72.54	11.27	12.58	11.16	8.10	9.13	41
1980	25532	2823956	2713555	281047	211555	75.27	11.01	10.36	7.80	8.29	42	

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	26170	2966319	2726781	298471	234843	78.68	10.42	11.41	10.95	8.61	8.97	51
1982	26281	2848175	2774623	296400	239759	80.89	10.56	11.28	10.68	8.64	9.12	43
1983	26608	2751774	2710570	251829	199199	79.10	10.19	9.46	9.29	7.35	7.49	50
1984	27345	2840240	2785297	283927	226279	79.69	10.19	10.38	10.19	8.12	8.27	49
1985	28171	2890683	2881534	246223	195800	79.52	10.23	8.74	8.54	6.79	6.95	67
1986	28535	2920805	2919182	316139	253011	80.03	10.23	11.08	10.83	8.67	8.87	155
1987	28864	3074172	3072925	237810	191759	80.64	10.65	8.24	7.74	6.24	6.64	90
1988	288827	2877100	2877100	206068	170845	82.91	1.00	0.71	7.16	5.94	0.59	82
1989	28827	3283782	3280617	260815	223364	85.64	11.38	9.05	7.95	6.81	7.75	118
1990	30057	3345706	3345706	290115	245806	84.73	11.13	9.65	8.67	7.35	8.18	147
1991	31062	3962971	3962971	414550	351062	84.69	12.76	13.35	10.46	8.86	11.30	233
1992	31505	3747038	3747038	362390	307056	84.73	11.89	11.50	9.67	8.19	9.75	155
1993	31208	3323788	320518	323576	274947	8	4.97	1.03	10.37-	85.78	8.81	118
1994	37354	3264061	3264061	332046	284346	85.63	8.74	8.89	10.17	8.71	7.61	78
1995(P)	37354	2554325	2520390	269310	227040	84.30	6.75	7.21	10.69	9.01	6.08	163

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

19. PUNJAB

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	*%Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	15565	881718	655778	1478	400	27.06	2.62	0.37	1.42	0.19	0.05	-
1962	17972	1704660	1719076	966	94	9.73	3.75	0.80	2.12	0.53	0.20	-
1963	18918	2478604	2459245	570	48	8.42	4.56	1.08	2.37	0.55	0.25	-
1964	19617	2577538	2569815	532	113	21.24	9.61	1.86	1.94	0.42	0.41	-
1965	20404	1782229	1760533	334	16	4.79	10.69	1.40	1.31	0.39	0.42	-
1966	11065	1044366	1035683	332	6	1.80	12.19	0.53	0.44	0.31	0.38	-
1967	11870	1032169	1018904	1835	2	0.10	11.65	0.97	0.83	0.69	0.80	-
1968	12550	1232682	1229260	9503	220	2.31	12.08	1.62	1.34	1.05	1.26	-
1969	13000	1432460	1426254	11220	5	0.04	10.50	1.43	1.36	1.05	1.10	-
1970	13330	1719909	1716756	15886	29	0.18	4.66	0.54	1.16	0.55	0.26	-
1971	13510	1793036	1789524	51372	19	0.03	5.83	1.54	2.63	1.07	0.63	-
1972	13780	1937599	1936093	99082	523	0.52	4.10	2.26	5.52	2.53	1.04	-
1973	14070	2289676	2289676	166346	21	0.01	8.44	8.19	9.70	4.06	3.42	-
1974	14300	1897158	1881650	230252	35	0.01	8.50	12.64	14.86	7.72	6.57	-
1975	14300	1871839	1861870	288214	191	0.06	9.05	13.49	14.90	6.93	6.27	-
1976	14532	2692960	2692843	440465	479	0.10	8.66	13.74	15.87	10.14	8.78	1
1977	15018	3675363	3673877	529147	1107	0.20	7.69	8.72	11.34	7.31	5.62	-
1978	15584	3607522	3607522	467558	1484	0.31	10.84	15.16	13.98	10.09	10.93	-
1979	16441	2903124	2903124	325227	1326	0.40	11.27	12.58	11.16	8.10	9.13	-
1980	16690	2701157	2701157	228478	3827	1.67	10.63	11.01	10.36	7.80	8.29	.

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	16754	2963898	2907352	232071	8450	3.64	10.42	11.41	10.95	8.61	8.97	-
1982	17124	2997388	2997388	207925	11652	5.60	10.56	11.28	10.68	8.64	9.12	-
1983	17443	3130758	3130758	177265	25917	14.62	10.19	9.46	9.29	7.35	7.49	41
1984	17772	3836716	3836687	216098	40866	18.91	10.19	10.38	10.19	8.12	8.27	58
1985	18834	3843949	3843949	223756	27306	12.20	20.41	11.88	5.82	0.71	1.45	29
1986	19289	3257953	3257953	174012	13114	7.54	16.89	9.02	5.34	0.40	0.68	11
1987	19336	2699007	2698967	86604	862	1.00	13.96	4.48	3.21	0.03	0.04	0
1988	19439	2629364	2629253	33342	625	1.87	13.53	1.72	1.27	0.02	0.03	0
1989	19816	2443050	2442977	32146	833	2.59	12.33	1.62	1.32	0.03	0.04	2
1990	20129	2226775	2226775	29336	579	1.97	11.06	1.46	1.32	0.03	0.03	0
1991	20547	2574396	2574396	36649	365	1.00	12.53	1.78	1.42	0.01	0.02	0
1992	21143	2535885	2535885	23225	184	0.79	11.99	1.10	0.92	0.01	0.01	0
1993	21539	2494395	2494395	15944	73	0.46	11.58	0.74	0.64	0.00	0.00	0
1994	21895	2575691	2575691	15601	185	1.18	11.76	0.71	0.61	0.01	0.71	1
1995(P)	21895	2362413	2361514	26912	2396	8.90	10.79	1.23	1.14	0.10	0.71	8

20. RAJASTHAN

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	17562	669202	595176	8494	3266	38.45	3.39	0.48	1.43	0.55	0.19	-
1962	18785	943159	1082915	3210	508	15.82	5.76	0.17	0.30	0.05	0.03	-
1963	19048	1779180	1743916	3813	1210	31.73	9.16	0.20	0.22	0.07	0.06	-
1964	20917	2200707	2184182	3164	826	26.10	10.44	0.15	0.14	0.04	0.04	-
1965	22001	2212563	2183592	2872	348	12.11	9.92	0.13	0.13	0.02	0.02	-
1966	22454	1863401	1857961	9680	532	5.49	8.27	0.43	0.52	0.03	0.02	-
1967	23040	1772313	1763870	23898	1221	5.10	7.66	1.04	1.35	0.07	0.05	-
1968	23850	1661789	1659286	14999	923	6.15	6.96	0.63	0.90	0.06	0.04	-
1969	24670	1485220	1471587	15487	1158	7.47	5.97	0.63	1.05	0.08	0.05	-
1970	25320	1741741	1736028	79788	4985	6.24	6.86	3.15	4.60	0.29	0.20	-
1971	25850	2184134	2174281	109773	8064	7.34	8.41	4.25	5.05	0.37	0.31	-
1972	26510	5037069	2215322	82517	8470	10.26	8.36	3.11	3.72	0.38	0.32	-
1973	26715	2233100	2162576	118012	16451	13.94	8.09	4.42	5.46	0.76	0.62	-
1974	27560	2694698	2688624	177596	13663	7.69	9.76	6.44	6.61	0.51	0.50	-
1975	27560	3186044	3062207	354567	31304	8.82	11.11	12.87	11.58	1.02	1.14	-
1976	28031	3578216	3572281	412776	24163	5.85	12.74	14.73	11.55	0.68	0.86	-
1977	29104	3318120	3318120	231862	12445	5.36	11.40	7.97	6.99	0.38	0.43	-
1978	29670	3260421	3226710	154549	8612	5.57	10.88	5.21	4.79	0.27	0.29	-
1979	31092	3515605	3515605	83394	4670	5.59	11.31	2.68	2.37	0.13	0.15	-
1980	31594	4208295	4208295	96118	15871	16.51	13.32	3.04	2.28	0.38	0.50	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	32492	3992445	3991672	100654	14752	14.65	12.29	3.10	2.52	0.37	0.45	-
1982	33113	3284810	3284810	75320	12296	16.32	9.92	2.27	2.29	0.37	0.37	1
1983	33583	3161396	3161396	115177	35462	30.78	9.41	3.43	3.64	1.12	1.06	-
1984	34124	2901731	2901731	101955	20443	20.05	8.50	2.99	3.51	0.70	0.60	-
1985	34655	3037182	3037182	67040	12643	18.86	8.76	1.93	2.21	0.42	0.36	4
1986	34897	2941659	2941659	54618	13890	25.43	8.43	1.57	1.86	0.47	0.40	2
1987	35378	3219363	3219363	65523	13942	21.28	9.10	1.85	2.04	0.43	0.39	0
1988	35457	3493559	3493559	104109	29189	28.04	9.85	2.94	2.98	0.84	0.82	2
1989	35683	3074207	3074207	112316	24072	21.43	8.62	3.15	3.65	0.78	0.67	1
1990	35854	3567539	114689	32500		28.34	9.95	3.20	3.21	0.91	0.91	65
1991	43881	3179925	3179925	77573	16097	20.75	7.25	1.77	2.44	0.51	0.37	10
1992	43880	3833880	3833880	121499	41513	34.17	8.74	2.77	3.17	1.08	0.95	55
1993	44005	3644944	3644944	107797	26387	24.48	0.82	0.24	2.96	0.72	0.06	19
1994	44005	4855841	4855841	241255	94020	38.97	11.04	5.48	4.97	1.94	2.13	452
1995(P)	44001	4607492	4607492	215265	30330	14.08	10.00	4.89	4.67	0.66	0.69	45

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

21. SIKKIM

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	130	77	77	3	1	33.33	0.06	0.02	3.90	1.30	0.01	-
1962	135	507	507	45	8	17.77	0.38	0.33	8.88	1.58	0.06	-
1963	140	1099	1099	68	6	8.82	0.79	0.49	6.19	0.55	0.04	-
1964	143	4875	4875	142	25	17.60	3.41	0.99	2.91	0.51	0.17	-
1965	147	32927	32927	89	1	1.12	22.40	0.61	0.27	0.00	0.01	-
1966	150	33358	33358	37	4	10.81	22.24	0.25	0.11	0.01	0.03	-
1967	150	42288	42288	25	3	0.12	28.19	0.17	0.06	0.01	0.02	-
1968	150	45301	45301	34	0	0.00	30.20	0.23	0.08	0.00	0.00	-
1969	154	49098	49098	19	1	5.26	31.88	0.12	0.04	0.00	0.01	-
1970	156	43444	43444	29	2	6.89	27.85	0.19	0.07	0.00	0.01	-
1971	161	36230	36230	34	1	2.94	22.50	0.21	0.09	0.00	0.01	-
1972	163	40649	40649	77	2	2.59	24.94	0.47	0.19	0.00	0.01	-
1973	165	36857	36857	196	26	13.26	22.34	1.19	0.53	0.07	0.16	-
1974	163	37634	37634	188	26	13.82	22.40	1.12	0.50	0.07	0.15	-
1975	168	33120	33120	134	12	8.95	19.71	0.80	0.40	0.04	0.07	-
1976	169	28320	28320	113	6	5.30	16.76	0.67	0.40	0.02	0.04	-
1977	170	32497	32497	98	1	1.02	19.12	0.58	0.30	0.00	0.01	-
1978	173	28400	28400	45	4	8.88	16.42	0.26	0.16	0.01	0.02	-
1979	176	28777	28777	66	11	16.66	16.35	0.38	0.23	0.04	0.06	-
1980	179	30168	30168	44	5	11.36	16.85	0.25	0.15	0.02	0.03	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	182	29298	29298	40	2	0.05	16.10	0.22	0.14	0.01	0.01	-
1982	189	30455	30455	49	1	2.04	16.11	0.26	0.16	0.00	0.01	-
1983	197	29276	29276	35	12	34.28	14.86	0.18	0.12	0.04	0.06	-
1984	202	29611	29611	27	2	7.40	14.66	0.13	0.09	0.01	0.01	-
1985	206	31019	31019	57	7	12.28	15.06	0.28	0.18	0.02	0.03	0
1986	213	29071	29071	45	3	6.67	13.65	0.21	0.15	0.01	0.01	0
1987	220	28284	28284	24	0	0.00	12.86	0.11	0.08	0.00	0.00	0
1988	222	28941	28941	23	2	8.70	13.04	0.10	0.08	0.01	0.01	0
1989	225	25905	25905	30	5	16.67	11.51	0.13	0.12	0.02	0.02	0
1990	225	24927	24927	17	4	23.53	11.08	0.08	0.07	0.02	0.02	0
1991	236	26909	26909	46	4	8.70	11.40	0.19	0.17	0.01	0.02	0
1992	245	28305	28305	208	149	71.63	11.55	0.85	0.73	0.53	0.61	1
1993	259	20916	20916	68	36	52.94	8.08	0.26	0.33	0.17	0.14	0
1994	259	16575	16575	58	8	13.79	9.16	0.32	0.35	0.05	0.32	0
1995(P)	181	16463	16463	58	8	13.79	9.10	0.32	0.35	0.05	0.04	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

22. TAMIL NADU

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	31062	1489934	1365890	2061	1181	57.30	4.40	0.07	0.15	0.09	0.04	-
1962	33678	2939959	2948407	1412	762	53.96	8.75	0.04	0.05	0.02	0.01	-
1963	34142	4822048	3991186	3091	358	11.58	13.45	0.09	0.07	0.01	0.01	-
1964	35681	4193071	4191071	896	65	7.25	11.75	0.03	0.02	0.00	0.00	-
1965	36051	4339222	4340196	563	49	8.70	12.04	0.02	0.01	0.00	0.00	-
1966	36735	3647935	3647935	265	12	4.52	9.94	0.01	0.01	0.00	0.00	-
1967	37680	3265851	3265851	183	9	4.91	8.67	0.00	0.01	0.00	0.00	-
1968	38120	3433294	3433294	356	122	34.26	9.01	0.01	0.01	0.00	0.00	-
1969	38680	3328051	3328051	761	302	39.68	8.60	0.02	0.02	0.01	0.01	-
1970	39260	3347947	3347947	1300	579	44.53	8.53	0.03	0.04	0.02	0.01	-
1971	39970	3185532	3185532	1557	436	28.00	7.97	0.04	0.05	0.01	0.01	-
1972	40035	3147838	3147838	1518	561	36.95	7.86	0.04	0.05	0.02	0.01	-
1973	40925	2976643	2976643	5869	1848	31.48	7.27	0.14	0.20	0.06	0.05	-
1974	41460	3028771	3028383	19657	6567	33.40	7.30	0.47	0.65	0.22	0.16	-
1975	41640	3057676	3055276	74579	2573	3.45	7.34	1.79	2.44	0.08	0.06	-
1976	42145	3457968	3430841	103921	4087	3.93	8.14	2.47	3.03	0.16	0.10	-
1977	43651	2973343	2823779	83300	3082	3.69	6.47	1.91	2.95	0.11	0.07	-
1978	45663	3338422	3235013	76227	1512	1.98	7.08	1.67	2.36	0.05	0.03	-
1979	46611	3558296	3474071	95009	3085	3.24	7.45	2.04	2.73	0.09	0.07	-
1980	47352	3997348	3997348	73381	2799	3.81	8.44	1.55	1.84	0.07	0.06	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	48189	4666321	4666321	71517	2531	3.53	9.68	1.48	1.53	0.05	0.05	-
1982	48270	4405129	4405129	65797	3048	4.63	9.13	1.36	1.49	0.07	0.06	-
1983	48335	3921766	3921766	67192	4841	7.20	8.11	1.39	1.71	0.12	0.10	-
1984	48358	4763343	4482583	71320	4724	6.62	9.27	1.47	1.59	0.11	0.10	-
1985	52154	5385140	5385140	71347	4229	5.93	10.33	1.37	1.32	0.08	0.08	0
1986	52970	6948769	6948769	58741	3398	5.78	13.12	.111	0.85	0.05	0.06	0
1987	54452	6921215	6921215	55523	3588	6.46	12.71	1.02	0.80	0.05	0.07	0
1988	54742	5248565	5248565	5093	6.71	9.59	1.39	1.45	0.10	0.09	0	
1989	55714	4117144	4117144	90478	4244	4.69	7.39	1.62	2.20	0.10	0.08	0
1990	55897	5003741	5003741	120029	7039	5.86	8.95	2.15	2.40	0.14	0.13	0
1991	55918	5187871	5187871	144762	12193	8.42	9.28	2.59	2.79	0.24	0.22	4
1992	56763	6016637	6016637	151633	12112	7.99	10.60	2.58	0.67	2.52	0.20	2
1993	57925	6370485	6370485	148057	8844	5.97	11.00	2.56	2.32	0.14	0.15	9
1994	58841	6264791	6264791	104964	4935	4.70	-	10.65	1.78	1.68	0.08	7
1995(P)	58841	4887995	4883318	76825	4986	6.49	8.30	1.31	1.57	0.10	0.08	1

23. TRIPURA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	1032	575	41	38		92.68	0.06	0.04	7.13	6.61	0.04	-
1962	1067	2295	2295	140	88	62.85	0.22	0.13	6.10	3.83	0.08	-
1963	1115	18718	18718	559	284	50.80	1.68	0.50	2.99	1.52	0.25	-
1964	1165	25610	25610	808	132	16.33	2.20	0.69	3.16	0.52	0.11	-
1965	1172	7527	7527	831	130	15.64	0.64	0.71	11.04	1.73	0.11	-
1966	1262	56730	42846	1825	1148	62.90	3.40	1.45	4.26	2.68	0.91	-
1967	1320	98601	64419	3861	2102	54.44	4.88	2.93	5.99	3.26	1.59	-
1968	1340	125200	99903	7507	4689	62.46	7.46	5.60	7.51	4.69	3.50	-
1969	1368	135174	113127	7369	3197	43.38	8.27	5.39	6.51	2.83	2.34	-
1970	1405	119337	114538	4247	1732	40.78	8.15	3.02	3.71	1.51	1.23	-
1971	1456	123022	102607	2772	1039	37.48	7.05	1.90	2.70	1.01	0.71	-
1972	1500	106331	88908	6579	2907	44.18	5.93	4.39	7.40	3.27	1.94	-
1973	1540	90779	90779	5171	2945	56.95	5.89	3.36	5.70	3.24	1.91	-
1974	1660	91158	80759	3562	1993	55.95	4.87	2.15	4.41	2.47	1.20	-
1975	1660	158588	126255	8002	5257	65.69	7.61	4.82	6.34	4.16	3.17	-
1976	1665	152646	135593	7171	5123	71.44	8.14	4.31	5.29	3.78	3.08	-
1977	1705	1147330	102684	4332	2822	65.14	6.02	2.54	4.22	2.75	1.66	5
1978	1780	164953	164953	12918	8143	63.03	9.27	7.26	7.83	4.94	4.57	27
1979	1800	153299	138187	10769	8053	74.77	7.68	5.98	7.79	5.83	4.47	27
1980	2010	126056	122679	6364	4945	77.70	6.10	3.17	5.19	4.03	2.46	5

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	2049	124178	120656	6182	5280	85.40	5.89	3.02	5.12	4.38	2.58	13
1982	2049	190331	183792	10596	8545	80.64	8.97	5.17	5.77	4.65	4.17	17
1983	2103	201538	201538	10176	8222	80.79	9.58	9.58	4.84	5.05	4.08	13
1984	2312	225207	225207	13126	11581	88.22	9.74	5.68	5.83	5.14	5.01	24
1985	2324	172900	172900	8334	6932	83.18	7.44	3.59	4.82	4.01	2.98	8
1986	2397	153417	153417	9318	8053	86.42	6.40	3.89	6.07	5.25	3.36	11
1987	2407	170060	170060	8107	7245	89.37	7.07	3.37	4.77	4.26	3.01	5
1988	2407	173704	173704	6178	5319	86.10	7.22	2.57	3.56	3.06	2.21	1
1989	2397	185731	181090	5991	4265	71.19	7.55	2.50	3.31	2.36	1.78	5
1990	2397	210106	207595	6633	5068	76.41	8.66	2.77	3.20	2.44	2.11	4
1991	2750	174985	170912	6992	5314	76.00	6.21	2.54	4.09	3.11	1.93	7
1992	2756	179404	175393	9350	6970	74.55	6.36	3.39	5.33	3.97	2.53	6
1993	2757	188367	185565	9206	7223	78.46	6.73	3.34	4.96	3.89	2.62	19
1994	2827	232243	232243	8871	6975	78.62	8.22	3.14	3.82	3.00	2.46	20
1995(P)	2827	76611	76611	11546	9681	83.84	2.71	4.08	15.07	12.64	3.42	12

24. UTTAR PRADESH

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	64540	2911618	2870835	3117	1033	33.14	4.45	0.05	0.11	0.04	0.02	-
1962	68982	5196523	5162967	3525	974	27.63	7.48	0.05	0.07	0.02	0.01	-
1963	72895	6833090	6717780	5194	1507	29.01	9.22	0.07	0.08	0.02	0.02	-
1964	77902	8851901	8659129	4126	1129	27.36	11.12	0.05	0.05	0.01	0.01	-
1965	78618	6198637	6066788	3365	455	13.52	7.72	0.04	0.06	0.01	0.01	-
1966	80065	4267443	4063684	10222	392	3.83	5.08	0.13	0.25	0.01	0.00	-
1967	81570	4396147	4241586	12298	651	5.29	5.20	0.15	0.29	0.02	0.01	-
1968	83460	4764014	4631357	6649	146	2.19	5.55	0.08	0.14	0.00	0.00	-
1969	84690	5133326	5029118	3785	164	4.33	5.94	0.04	0.08	0.00	0.00	-
1970	86420	4970907	4784313	7779	362	4.65	5.54	0.09	0.16	0.01	0.00	-
1971	87405	4841146	4702966	9891	755	7.63	5.38	0.11	0.21	0.02	0.01	-
1972	88215	5175316	5055322	17676	846	4.78	5.73	0.20	0.35	0.02	0.01	-
1973	88880	4657770	4637556	52052	1851	3.55	5.22	0.59	1.12	0.04	0.02	-
1974	89070	5758863	5630990	193715	4072	2.10	6.32	2.17	3.44	0.07	0.05	-
1975	89070	6459338	6327977	381750	8686	2.27	7.10	4.29	6.03	0.14	0.10	-
1976	89785	5529990	5529990	337728	10798	3.19	6.16	3.76	6.11	0.20	0.12	1
1977	91712	7381525	7294575	433944	14533	3.34	7.95	4.75	5.95	0.20	0.16	1
1978	98030	8766528	8675515	360059	8472	2.35	8.85	3.67	4.15	0.10	0.09	-
1979	100805	8062302	7984603	149919	2365	1.57	7.92	1.49	1.88	0.03	0.02	-
1980	102682	9299737	9215846	182308	10871	5.96	8.98	1.78	1.98	0.12	0.11	-

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	104416	8919224	8839472	175930	11211	6.37	8.47	1.68	1.99	0.13	0.11	-
1982	108228	7500914	7463761	170233	9.57	6.90	1.57	2.28	0.22	0.15	-	
1983	109760	8156000	8068000	285618	65915	23.07	7.35	2.60	3.54	0.82	0.60	16
1984	114636	9186000	9147000	419708	63675	15.17	7.98	3.66	4.59	0.70	0.56	-
1985	117115	8757000	8731000	373006	55010	14.75	7.46	3.18	4.27	0.63	0.47	0
1986	119187	7832000	7801000	228244	19384	8.49	6.55	1.92	2.93	0.25	0.16	0
1987	120832	8003000	7987000	126181	10496	8.32	6.61	1.04	1.58	0.13	0.09	0
1988	123678	9519000	9492000	135096	9918	7.34	7.67	1.09	1.42	0.10	0.08	0
1989	123678	8898000	8886000	101815	6601	6.48	7.18	0.82	1.15	0.07	0.05	0
1990	127444	9396000	9371000	103222	7645	7.41	7.35	0.81	1.10	0.08	0.06	0
1991	129182	9724000	9695000	112118	9112	8.13	7.50	0.87	1.16	0.09	0.07	0
1992	130494	9924000	9885000	135242	12324	9.11	7.58	1.04	1.37	0.12	0.09	0
1993	131260	8664000	8659000	114017	5930	5.20	6.60	0.87	1.32	0.07	0.05	0
1994	122843	8042000	8042000	89617	7516	8.38	6.55	0.73	1.11	0.09	0.06	0
1995(P)	122843	7804767	7473738	99513	6549	6.58	6.80	0.81	1.33	0.09	0.05	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

25. WEST BENGAL

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	22870	-	9190	160	4	2.5	0.04	0.01	1.74	0.04	0.00	-
1962	25465	927805	927805	157	53	33.75	3.64	0.01	0.02	0.01	0.00	-
1963	28026	2368146	2012282	472	98	20.76	7.18	0.02	0.02	0.00	0.00	-
1964	34794	3012735	2948600	860	117	13.60	8.47	0.02	0.03	0.00	0.00	-
1965	36901	2938970	2874423	273	30	10.98	7.79	0.01	0.01	0.00	0.00	-
1966	37680	2429688	2392826	425	99	23.29	6.35	0.01	0.02	0.00	0.00	-
1967	38800	1948732	1870705	1996	62	3.10	4.82	0.05	0.11	0.00	0.00	-
1968	40740	1981955	1972403	2460	753	30.60	4.84	0.06	0.12	0.04	0.02	-
1969	42950	1406279	1423817	423	38	8.98	3.32	0.01	0.03	0.00	0.00	-
1970												
1971	44200	1314053	1305088	965	93	9.63	2.95	0.02	0.07	0.01	0.00	-
1972	45070	1396428	1281333	3638	352	9.67	2.84	0.08	0.28	0.03	0.01	-
1973	45985	1036045	1036045	12433	308	2.47	2.25	0.27	1.20	0.03	0.01	-
1974	46720	1318340	982201	19387	1757	9.06	2.10	0.41	1.97	0.18	0.04	-
1975	46720	1878220	1878220	39634	8304	20.95	4.02	0.85	2.11	0.44	0.18	4
1976	47032	2362910	2362910	28917	1855	6.41	5.02	0.61	1.22	0.08	0.04	2
1977	47415	2140879	2140879	15722	168	1.06	4.52	0.33	0.73	0.01	0.00	1
1978	47906	1630783	1495246	11850	429	3.62	3.12	0.25	0.79	0.03	0.01	1
1979	48906	1639073	1639073	11909	665	5.58	3.35	0.24	0.73	0.04	0.01	1
1980	50589	1749125	1749125	22219	1733	7.79	3.46	0.44	1.27	0.10	0.03	3

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	51062	1929875	1929875	30717	2603	8.47	3.78	0.60	1.59	0.13	0.05	4
1982	51262	1899784	1899784	34237	4991	14.57	3.71	0.67	1.80	0.26	0.10	21
1983	51796	1547410	1547410	41861	4161	9.94	2.99	0.81	2.71	0.27	0.08	4
1984	53840	1346307	1346307	46340	5761	12.43	2.50	0.86	3.44	0.43	0.11	6
1985	54151	1716255	1694488	46814	10844	23.16	3.13	0.86	2.76	0.64	0.20	14
1986	54997	1460950	1460950	53620	14096	26.29	2.66	0.97	3.67	0.96	0.26	20
1987	56100	1869982	1869982	46029	9403	20.43	3.33	0.82	2.46	0.50	0.17	17
1988	59197	2156472	2156472	36318	5524	15.21	3.64	0.61	1.68	0.26	0.09	5
1989	57697	164260	164260	35624	6484	18.20	0.28	0.62	21.69	3.95	0.11	16
1990	57697	1610243	1610243	27531	3690	13.40	2.79	0.48	1.71	0.23	0.06	4
1991	57822	1845197	1845197	40452	7771	19.21	3.19	0.70	2.19	0.42	0.13	13
1992	58766	2474897	2474897	49130	3690	7.51	4.21	0.84	1.99	0.15	0.06	43
1993	59158	2077909	2077909	46138	6763	14.66	3.51	0.78	2.22	0.33	0.11	37
1994	61733	2535771	2535771	74283	15392	20.72	4.11	1.20	2.93	0.61	0.24	52
1995(P)	61733	1988161	1766987	62502	9520	15.23	2.88	0.01	3.54	0.54	0.15	107*

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

26. A & N ISLANDS

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	50	-	3380	495	9	1.81	6.76	9.90	14.64	0.27	0.18	-
1962	54	9918	9918	502	0	0.00	18.37	9.30	5.06	0.00	0.00	-
1963	57	26564	27195	1308	6	0.45	47.71	22.95	4.81	0.02	0.11	-
1964	60	23166	23166	461	5	1.08	38.61	7.68	1.99	0.02	0.08	-
1965	63	22657	22645	442	15	3.39	35.94	7.02	1.95	0.07	0.24	-
1966	65	23659	23659	120	14	11.66	36.40	1.85	0.51	0.06	0.22	-
1967	70	40474	40474	927	167	18.01	57.82	13.24	2.29	0.41	2.39	-
1968	75	38728	38728	1874	251	13.39	51.64	24.99	4.84	0.65	3.35	-
1969	80	46045	46045	1874	302	16.11	57.56	23.43	4.07	0.66	3.78	-
1970	85	54946	54946	2939	222	7.55	64.64	34.58	5.35	0.40	2.61	-
1971	90	56376	56376	1753	50	2.85	62.64	19.48	3.11	0.09	0.56	-
1972	100	55705	55705	3060	357	11.66	55.71	30.60	5.49	0.64	3.57	-
1973	110	51478	51478	1519	40	2.63	46.80	13.81	2.95	0.08	0.36	-
1974	120	50575	50575	1178	70	5.94	42.15	9.82	2.33	0.14	0.58	-
1975	120	46819	46819	1106	109	9.85	39.02	9.22	2.36	0.23	0.91	-
1976	128	47932	47932	1510	62	4.10	37.45	11.80	3.15	0.13	0.48	-
1977	140	62535	62535	2820	88	3.12	44.67	20.14	4.51	0.14	0.63	1
1978	150	58668	58668	2810	267	9.50	39.13	18.73	4.79	0.45	1.78	-
1979	160	61208	61208	7481	786	10.50	38.26	46.70	12.22	1.28	4.91	-
1980	166	83866	83866	9842	1073	10.90	50.52	59.29	11.74	1.28	6.46	30

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	190	76044	76044	5045	702	13.91	40.02	26.55	6.63	0.92	3.69	4
1982	200	72626	72626	3470	431	12.42	36.31	17.35	4.78	0.66	2.41	1
1983	215	86096	86096	6455	734	11.37	40.04	30.02	7.50	0.85	3.41	2
1984	230	109446	109446	4054	489	12.06	47.59	17.63	3.70	0.45	2.13	1
1985	244	115763	115763	3648	677	18.56	47.44	14.95	3.15	0.58	2.77	0
1986	217	120731	120731	3276	537	16.39	55.64	15.10	2.71	0.44	2.47	0
1987	261	139935	139935	3271	633	19.35	53.61	12.53	2.34	0.45	2.43	1
1988	272	142631	142631	3360	782	23.27	52.44	12.35	2.36	0.55	2.88	1
1989	280	149419	149419	2655	560	21.09	53.36	9.48	1.78	0.37	2.00	1
1990	288	150723	150723	2391	372	15.56	52.33	8.30	1.59	0.25	1.29	0
1991	297	141822	141822	1765	296	16.77	47.75	5.94	1.24	0.21	1.00	2
1992	306	160992	160992	1688	297	17.59	52.61	5.52	1.05	0.18	0.97	1
1993	344	161772	161772	1598	320	20.03	47.03	4.65	0.99	0.20	0.93	1
1994	359	183283	183283	1619	270	16.67	51.05	4.51	0.88	0.15	-	1
1995(P)	359	190610	190610	1501	292	19.45	53.09	4.18	0.79	0.15	0.81	2

27. CHANDIGARH

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1966	164	1293	1293	0	0	0.00	0.79	0.00	0.00	0.00	0.00	-
1967	192	1808	1808	0	0	0.00	0.94	0.00	0.00	0.00	0.00	-
1968	201	3962	3962	5	0	0.00	1.97	0.02	0.13	0.00	0.00	-
1969	215	463	463	1	0	0.00	0.22	0.00	0.22	0.00	0.00	-
1970	229	463	463	1	0	0.00	0.20	0.00	0.22	0.00	0.00	-
1971	235	463	463	1	0	0.00	0.20	0.00	0.22	0.00	0.00	-
1972	280	6968	6968	17	0	0.00	2.49	0.06	0.24	0.00	0.00	-
1973	300	23329	23329	917	0	0.00	7.78	3.06	3.93	0.00	0.00	-
1974	340	44390	44390	2373	2	0.08	13.06	6.98	5.35	0.00	0.01	-
1975	340	55715	55715	4269	1	0.02	16.39	12.56	7.66	0.00	0.00	-
1976	375	72315	72315	10535	4	0.37	19.28	28.09	14.57	0.01	0.01	-
1977	400	99451	99451	34624	7	0.02	24.86	86.56	34.82	0.01	0.02	-
1978	415	116323	116323	38676	5	0.01	28.03	93.20	33.25	0.00	0.01	-
1979	430	115643	115643	36453	11	0.03	26.89	84.77	31.52	0.01	0.03	-
1980	440	144370	144370	42725	68	0.15	32.81	97.10	29.59	0.05	0.15	-
1981	450	124084	124084	34215	136	0.39	27.57	76.03	27.57	0.11	0.30	-
1982	450	111191	111191	26125	257	0.98	24.71	58.06	23.50	0.23	0.57	-
1983	472	104461	104461	23306	669	2.87	22.13	49.38	22.31	0.64	1.42	-
1984	475	104435	104435	24292	1265	5.20	21.99	51.14	23.26	1.21	2.66	-
1985	525	164737	164737	37546	607	1.62	31.38	71.52	22.79	0.37	1.16	0

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1986	550	169457	169457	30723	148	0.48	30.81	55.86	18.13	0.09	0.27	2
1987	575	164714	164714	19349	26	0.13	28.65	33.65	11.75	0.02	0.05	0
1988	600	164311	164311	14157	23	0.16	27.39	23.60	8.62	0.01	0.04	0
1989	600	143482	143482	15405	5	0.03	23.91	25.68	10.74	0.00	0.01	0
1990	600	147004	147004	26813	94	0.35	24.50	44.69	18.24	0.06	0.16	0
1991	635	153645	153645	26046	31	0.12	24.20	41.02	16.95	0.02	0.05	0
1992	650	147436	147436	17559	29	0.17	22.68	27.01	11.91	0.02	0.04	0
1993	660	115697	115697	9735	31	0.32	17.53	14.75	8.41	0.03	0.05	0
1994	670	98233	98233	7853	59	0.75	14.66	11.72	7.99	0.06	11.72	0
1995(P)	670	104170	104170	9723	51	0.52	15.55	14.51	9.33	0.05	0.08	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1979 to 1995

28. DADRA & NAGAR HAVELI

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1979	86	10280	10267	1937	207	10.68	11.94	22.52	18.87	2.02	2.41	-
1980	86	20972	20972	3676	479	13.03	24.39	42.74	17.53	2.28	5.57	-
1981	104	20968	20968	3198	151	4.72	20.16	30.75	15.26	0.72	1.45	-
1982	104	16116	16103	1963	67	3.41	15.48	18.88	12.19	0.42	0.64	-
1983	104	13000	12985	1660	69	4.15	12.49	15.96	12.78	0.53	0.66	-
1984	104	13756	13748	1640	19	1.15	13.22	15.77	11.93	0.14	0.18	-
1985	104	14066	13954	2400	25	1.04	13.42	23.08	17.20	0.18	0.24	0
1986	104	15419	15417	4150	161	3.88	14.82	39.90	26.92	1.04	1.55	0
1987	104	21389	21389	5625	270	4.80	20.57	54.09	26.30	1.26	2.60	0
1988	104	25605	25605	5845	349	5.97	24.62	56.20	22.83	1.36	3.36	0
1989	104	22934	22934	4741	68	1.43	22.05	45.59	20.67	0.30	0.65	0
1990	104	23633	23633	5015	190	3.79	22.72	48.22	21.22	0.80	1.83	0
1991	138	24903	24903	5101	362	7.10	18.05	36.96	20.48	1.45	2.62	0
1992	138	44412	44412	6676	787	11.79	32.18	48.38	15.03	1.77	5.70	0
1993	138	47138	47138	8121	865	10.65	34.16	58.85	17.23	1.84	6.27	0
1994	138	41494	41494	8571	1362	15.89	30.07	62.11	20.66	3.28	9.86	0
1995(P)	138	58261	49515	12821	2977	23.21	35.88	92.91	25.89	6.01	21.57	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1963 to 1995

29. DAMAN & DIU

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1963	545	18260	15993	115	0	0.00	2.93	0.21	0.72	0.00	0.00	0
1964	565	50465	50381	175	1	0.57	8.92	0.31	0.35	0.00	0.00	0
1965	595	51657	51657	35	0	0.00	8.68	0.06	0.07	0.00	0.00	0
1966	610	55055	55039	3	0	0.00	9.02	0.00	0.01	0.00	0.00	0
1967	620	69119	69030	11	0	0.00	11.13	0.02	0.02	0.00	0.00	0
1968	640	65499	65388	9	0	0.00	10.22	0.01	0.01	0.00	0.00	0
1969	655	31743	33585	6	0	0.00	5.13	0.01	0.02	0.00	0.00	0
1970	670	20061	20098	12	0	0.00	3.00	0.02	0.06	0.00	0.00	0
1971	720	39150	37329	32	0	0.00	5.18	0.04	0.09	0.00	0.00	0
1972	740	42495	42495	104	0	0.00	5.74	0.14	0.24	0.00	0.00	0
1973	765	39644	36024	124	1	0.80	4.71	0.16	0.34	0.00	0.00	0
1974	770	56702	44340	165	3	1.81	5.76	0.21	0.37	0.01	0.00	0
1975	770	72003	72003	634	16	2.52	9.35	0.82	0.88	0.02	0.02	0
1976	785	99005	94621	2012	122	6.06	12.05	2.56	2.13	0.13	0.16	0
1977	825	68250	63393	2286	46	2.01	7.68	2.77	3.61	0.07	0.06	0
1978	909	70953	67462	450	11	2.44	7.42	0.50	0.67	0.02	0.01	0
1979	920	97193	97193	270	1	0.37	10.56	0.29	0.28	0.00	0:00	0
1980	971	99369	89664	2134	73	3.42	9.23	2.20	2.38	0.08	0.08	0

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	1078	79372	74505	1277	10	0.78	6.91	1.18	1.71	0.01	0.01	0
1982	1082	82338	82311	685	13	1.89	7.61	0.63	0.83	0.02	0.01	0
1983	1167	98635	96657	882	35	3.96	8.28	0.76	0.91	0.04	0.03	0
1984	1168	102157	102157	808	38	4.70	8.75	0.69	0.79	0.04	0.03	-
1985				625	16	6.25						
1986	90	16293	16293	394	19	4.82	18.10	4.38	2.42	0.12	0.21	0
1987	90	11124	11124	384	0	00.00	12.36	4.27	3.45	0.00	0.00	0
1988	79	15248	15248	779	32	4.11	19.30	9.86	5.11	0.21	0.41	0
1989	79	15275	15275	784	46	5.87	19.34	9.92	5.13	0.30	0.58	0
1990	79	19925	19463	770	44	5.71	24.64	9.75	3.96	0.23	0.56	0
1991	101	21304	21304	1010	33	3.27	21.09	10.00	4.74	0.15	0.33	0
1992	101	26409	26409	1199	86	7.17	26.15	11.87	4.54	0.33	0.85	0
1993	101	24041	24041	1565	45	2.88	23.80	15.50	6.51	0.19	0.45	0
1994	101	21345	21345	1236	47	3.80	21.13	12.24	5.79	0.22	12.23	0
1995(P)	101	27712	27664	1239	80	6.45	27.39	12.27	4.48	0.29	0.79	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

30. DELHI

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	1865	116593	116593	40	7	17.5	6.25	0.02	0.03	0.01	0.00	0
1962	2006	110973	110972	276	15	5.43	5.53	0.14	0.25	0.01	0.01	0
1963	2165	278262	278262	61	12	19.67	12.85	0.03	0.02	0.00	0.01	0
1964	2698	469763	469763	19	5	26.31	17.41	0.01	0.00	0.00	0.00	0
1965	2918	574242	574242	7	1	14.28	19.68	0.00	0.00	0.00	0.00	0
1966	3367	446654	446654	45	4	8.88	13.27	0.01	0.01	0.00	0.00	0
1967	3490	523129	523129	114	1	0.87	14.99	0.03	0.02	0.00	0.00	0
1968	3770	446144	467607	37	1	2.70	12.40	0.01	0.01	0.00	0.00	0
1969	3860	381721	377475	243	0	0.00	9.78	0.06	0.06	0.00	0.00	0
1970	4070	378141	381631	1056	6	0.56	9.38	0.26	0.28	0.00	0.00	0
1971	4260	312232	348572	3852	13	0.33	8.18	0.90	1.11	0.00	0.00	0
1972	4420	335668	334792	3578	103	2.87	7.57	0.81	1.07	0.03	0.02	0
1973	4500	261880	261880	3452	1	0.02	5.82	0.77	1.32	0.00	0.00	0
1974	4525	306786	302890	12163	5	0.04	6.69	2.69	4.02	0.00	0.00	0
1975	4525	544265	544260	37879	102	0.26	12.03	8.37	6.96	0.02	0.02	0
1976	4983	721257	721257	49330	89	0.18	14.47	9.90	6.84	0.01	0.02	0
1977	5217	1147279	1147279	178196	162	0.09	21.99	34.16	15.53	0.01	0.03	0
1978	5517	1952008	1952008	375077	144	0.03	35.38	67.99	19.21	0.01	0.03	0
1979	5967	1354192	1354192	98812	66	0.06	22.69	16.56	7.30	0.00	0.01	0
1980	6068	1350015	1350015	68227	249	0.36	22.25	11.24	5.05	0.02	0.04	0

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	6220	1351933	1351993	62415	817	1.30	21.74	10.03	4.62	0.06	0.13	0
1982	6370	1492770	1492770	46530	680	1.46	23.43	7.30	3.12	0.05	0.11	0
1983	6522	1555115	1555115	42107	1448	3.43	23.84	6.46	2.71	0.09	0.22	52
1984	7451	1589496	1589496	38108	646	1.69	21.33	5.11	2.40	0.04	0.09	40
1985	7451	1545929	1545929	32556	239	0.73	20.75	4.37	2.11	0.02	0.03	27
1986	7761	1205829	1205829	26613	77	0.29	15.54	3.43	2.21	0.01	0.01	0
1987	7761	924739	924739	14112	22	0.16	11.92	1.82	1.53	0.00	0.00	0
1988	8523	1048117	1048117	14423	20	0.14	12.30	1.69	1.38	0.00	0.00	0
1989	8523	896093	896093	10761	32	0.30	10.51	1.26	1.20	0.00	0.00	0
1990	8721	1070102	1070102	12044	89	0.74	12.27	1.38	1.13	0.01	0.01	0
1991	8852	988842	988842	8491	24	0.28	11.17	0.96	0.86	0.00	0.00	0
1992	9373	1122350	1122350	11241	90	0.80	11.97	1.20	1.00	0.01	0.01	1
1993	9259	1050623	1050623	8201	19	0.23	11.35	0.89	0.78	0.00	0.00	0
1994	10144	963826	963826	4365	22	0.50	9.50	0.43	0.45	0.00	0.43	0
1995(P)	10144	915631	915631	7167	22	0.30	9.03	0.71	0.78	0.00	0.00	0

31. LAKSHADWEEP

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1976	37	2149	2149	103	0	0.00	5.81	2.78	4.79	0.00	0.00	0
1977	38	4788	4788	97	0	0.00	12.60	2.55	2.03	0.00	0.00	0
1978	39	6029	6029	33	0	0.00	15.46	0.85	0.55	0.00	0.00	0
1979	39	3376	3376	15	0	0.00	8.66	0.38	0.44	0.00	0.00	0
1980	40	2278	2278	4	0	0.00	5.70	0.10	0.18	0.00	0.00	0
1981	40	1680	1680	0	0	0.00	4.20	0.00	0.00	0.00	0.00	0
1982	41	3376	3376	4	0	0.00	8.23	0.10	0.12	0.00	0.00	0
1983	41	1758	1758	5	0	0.00	4.29	0.12	0.28	0.00	0.00	0
1984	43	2234	2234	3	0	0.00	5.20	0.07	0.13	0.00	0.00	0
1985	44	1136	1136	1	0	0.00	2.58	0.02	0.09	0.00	0.00	0
1986	44	1566	1566	2	0	0.00	3.56	0.05	0.13	0.00	0.00	0
1987	45	879	879	3	0	0.00	1.95	0.07	0.34	0.00	0.00	0
1988	46	901	901	1	0	0.00	1.96	0.02	0.11	0.00	0.00	0
1989	40	2260	2260	4	0	0.00	5.65	0.10	0.18	0.00	0.00	0
1990	50	1556	1556	6	0	0.00	3.11	0.12	0.39	0.00	0.00	0
1991	51	2724	2724	4	0	0.00	5.34	0.08	0.15	0.00	0.00	0
1992	51	2343	2343	1	0	0.00	4.59	0.02	0.04	0.00	0.00	0
1993	51	4002	4002	5	5	100.00	7.85	0.10	0.12	0.12	0.10	0
1994	52	2657	2657	2	0	0.00	5.11	0.04	0.08	0.00	0.00	0
1995(P)	52	3528	3528	0	0	0.00	6.78	0.00	0.00	0.00	0.00	0

STATE-WISE EPIDEMIOLOGICAL SITUATION IN INDIA - 1975 to 1995

32. PONDICHERRY

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1975	420	37056	37056	174	4	2.29	7.51	0.41	0.55	0.01	0.01	0
1976	483	50990	45133	325	5	1.53	9.34	0.67	0.72	0.01	0.01	0
1977	534	56427	54252	326	5	1.53	10.16	0.61	0.60	0.01	0.01	0
1978	550	80453	75250	302	6	1.98	13.68	0.55	0.40	0.01	0.01	0
1979	560	106070	80067	378	6	1.58	14.30	0.68	0.47	0.01	0.01	0
1980	569	128993	126950	451	4	0.88	22.31	0.79	0.36	0.00	0.01	0
1981	569	130013	130013	414	2	0.48	22.85	0.73	0.32	0.00	0.00	0
1982	569	133049	133049	474	4	0.84	23.38	0.83	0.36	0.00	0.01	0
1983	604	175329	175329	434	1	0.23	29.03	0.72	0.25	0.00	0.00	0
1984	604	214685	214685	545	6	1.10	35.54	0.90	0.25	0.00	0.00	0
1985	604	215512	215512	274	6	2.19	35.68	0.45	0.13	0.00	0.01	0
1986	646	199507	199507	224	8	3.57	30.88	0.35	0.11	0.00	0.01	0
1987	647	202595	202595	220	4	1.82	31.31	0.34	0.11	0.00	0.01	0
1988	728	190874	190874	309	1	0.32	26.22	0.42	0.16	0.00	0.00	0
1989	728	206194	206194	541	1	0.18	28.32	0.74	0.26	0.00	0.00	0
1990	728	206295	206295	389	1	0.26	28.34	0.53	0.19	0.00	0.00	0
1991	728	239209	239209	563	4	0.71	32.86	0.77	0.24	0.00	0.01	0
1992	814	246285	246285	1034	13	1.26	30.26	1.27	0.42	0.01	0.02	0
1993	814	240455	240455	914	5	0.55	29.54	1.12	0.38	0.00	0.01	0
1994	814	212067	212067	548	9	1.64	26.05	0.67	0.26	0.00	0.00	0
1995	814	212067	212067	548	9	1.64	26.05	0.67	0.26	0.00	0.01	0

EPIDEMIOLOGICAL SITUATION IN INDIA - 1961 to 1995

INDIA

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1961	374316	15549527	13069336	49151	17141	34.87	3.49	0.13	0.38	0.13	0.05	-
1962	406331	26448639	26113381	59575	16674	27.98	6.43	0.15	0.23	0.06	0.04	-
1963	426237	40569431	38696888	87306	22750	26.05	9.08	0.20	0.23	0.06	0.05	-
1964	455064	45156381	44461585	112942	31490	27.88	9.77	0.25	0.25	0.07	0.07	-
1965	465889	41255864	40657215	99667	26163	26.25	8.73	0.21	0.25	0.06	0.06	-
1966	475991	40473143	39821399	148012	39618	26.76	8.37	0.31	0.37	0.10	0.08	-
1967	489122	41032343	40409129	278214	61984	22.27	8.26	0.57	0.69	0.15	0.13	-
1968	501828	42382606	41978449	274634	92714	33.75	8.37	0.55	0.65	0.22	0.18	-
1969	513939	42273354	41813880	347975	103217	29.66	8.14	0.68	0.83	0.25	0.20	-
1970	526715	42163826	40942093	694017	100115	14.42	7.77	1.32	1.70	0.24	0.19	-
1971	535162	41453924	40421795	1322398	148683	11.24	7.55	2.47	3.27	0.37	0.28	-
1972	547423	48975674	42801923	1428649	142177	9.95	7.82	2.61	3.34	0.33	0.26	-
1973	558766	44546662	42444458	1930273	265154	13.73	7.60	3.45	4.55	0.62	0.47	-
1974	567358	46975853	45452459	3167658	476922	15.05	8.01	5.58	6.97	1.05	0.84	3
1975	568168	53269227	51818351	5166142	729251	14.11	9.12	9.09	9.97	1.41	1.28	99
1976	575250	58081609	55978173	6467215	753713	11.65	9.73	11.24	11.55	1.35	1.31	59
1977	587310	59002187	57010347	4740930	461434	9.73	9.71	8.07	8.32	0.81	0.79	55
1978	609031	62276089	60462324	4144385	548567	13.23	9.93	6.80	6.85	0.91	0.90	74
1979	625304	62172471	61415178	3064697	558423	18.22	9.82	4.90	4.99	0.91	0.89	198
1980	642618	67823775	67173977	2898140	588011	20.28	10.45	4.51	4.31	0.88	0.92	207

Year	Pop. ('000 s)	BSC	BSE	+ve	*Pf*	%*Pf*	ABER	API	SPR	SfR	AFI	Deaths
1981	657745	68402122	67843105	2701141	589591	21.82	10.31	4.11	3.98	0.87	0.90	170
1982	677627	65336730	65032956	2182302	551057	25.25	9.60	3.22	3.36	0.85	0.81	187
1983	689605	64586467	64291752	2018605	600964	29.77	9.32	2.93	3.14	0.93	0.87	239
1984	710388	66886870	66355933	2184446	655454	30.00	9.34	3.08	3.29	0.99	0.92	247
1985	726340	68324652	68128289	1864380	545005	29.23	9.38	2.57	2.74	0.80	0.75	213
1986	737711	67842465	67690016	1792167	638276	35.61	9.18	2.43	2.65	0.94	0.87	323
1987	753549	72626983	72534799	1663284	618574	37.19	9.63	2.21	2.29	0.85	0.82	188
1988	766921	75848243	75698256	1854830	685407	36.95	9.87	2.42	2.45	0.91	0.89	209
1989	769316	72219651	72074937	2050064	755853	36.87	9.37	2.66	2.84	1.05	0.98	268
1990	784418	74533845	74422242	2018783	752118	37.26	9.49	2.57	2.71	1.01	0.96	353
1991	808102	75265438	75158681	2117460	918488	43.38	9.30	2.62	2.82	1.22	1.14	421
1992	824137	79108006	79011151	2125826	876246	41.22	9.59	2.58	2.69	1.11	1.06	422
1993	833885	77990335	77941025	2207431	852763	38.63	9.35	2.65	2.83	1.09	1.02	354
1994	861730	82179407	82179407	2511453	990508	39.43	9.54	2.91	3.06	1.20	1.14	1122
1995(P)	861730	70464771	68920692	2296008	792131	34.50	7.99	2.66	3.33	1.14	0.91	1012

(Annexure 3.1 - Continued from Page 94)

C. Entomological

1. Name of the vector(s)
2. If more than one vector, quantity the role and period of transmission of each vector
3. Vector(s) man-hour density
4. Man - biting rate
5. Susceptibility status to insecticide
6. Vector behaviour

   i). Exophilic/Endophilic
   ii). Exophagic/Endophagic

D. Environmental

1. Mean Temperature (Nov-Jan) (March-May)
2. Rainfall: Quantify
3. No. of rainy days
4. Floods/Draught, if occurred
5. Developmental projects (Quantify)
6. Deforestation/Afforestation (Quantify)
7. Agriculture practices (Quantify if any change).
8. Water supply/disposal (Quantify if any change) and water resources

E. Human Behaviouristic

1. Migration
2. Immigration from Pf resistant areas (Quantify)
3. Personal prophylactic measures

F. Overall summing up by investigator (s)

N.B.: If the gap between the first report of Pf.resistance and follow up investigation is more than five years, the average data of two to three years may be clubbed together for consecutive periods.